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SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey
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W90-01944 — W90-02544



The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1990.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

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Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

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08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

IMPLICATIONS OF TROPICAL DEFORESTATION FOR CLIMATE: A COMPARISON OF MODEL AND OBSERVATIONAL DESCRIPTIONS OF SURFACE ENERGY AND HYDROLOGICAL BALANCE.
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 4C.
W90-02152

IMPLEMENTATION OF THE THREE-DIMENSIONAL TURNING BANDS RANDOM FIELD GENERATOR.
California Univ., Livermore. Lawrence Livermore Lab.
For primary bibliographic entry see Field 7C.
W90-02201

MULTIOBJECTIVE SAMPLING DESIGN FOR PARAMETER ESTIMATION AND MODEL DISCRIMINATION IN GROUNDWATER SOLUTE TRANSPORT.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7A.
W90-02202

STUDY OF RAINFALL SIMULATORS, RUNOFF AND EROSION PROCESSES, AND NUTRIENT YIELDS ON SELECTED SITES IN ARIZONA AND NEW MEXICO.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
T. J. Ward, and S. B. Bolin.
New Mexico Water Resources Research Institute, New Mexico State University Technical Completion Report No. 241, April 1989. 68p, 3 fig, 23 tab, 17 ref, 7 append. WRRI Project 1423672.

Descriptors: *Simulation analysis, *Rainfall-runoff relationships, *Rainfall simulators, *Erosion, *Nutrients, Arizona, New Mexico, Mathematical models, Hydrologic models, Infiltration, Sediment yield.

Estimation of runoff and sediment yield from small, ungaged watersheds is a difficult hydrologic task. Process oriented mathematical models can be an important part in the solution of this task. Models, however, require some information which is directly related to the hydrologic processes occurring on the watershed. Rainfall simulation is an important experimental technique for gathering such information. This report contains the results of a study on the utility of using rainfall simulation in southwestern watersheds. Two different simulators were compared on three sites. At one site, three simulators were used, one of which was used to gather data at three additional sites. A small area simulator, 1 sq m, and two large area simulators, approximately 32.5 sq m, were operated for a total of about 74 plot experiments. Information was developed for rainfall rate, runoff rate, types and percent of ground cover, size and slope of the sampled plots, soil particle size gradation, soil water content, soil porosity, sediment yield, infiltration parameters, erosion parameters, and water chemistry. Analysis of the data indicates that the simulators provide similar results for infiltration characteristics, and that sediment yields were about 4.0 times higher for the small simulator. Numerous water chemistry samples were analyzed to determine potential nutrient loadings from forest and range lands to water bodies in New Mexico. (Lantz-PTT)
W90-02316

2B. Precipitation

LAND SURFACE HYDROLOGY PARAMETERIZATION FOR ATMOSPHERIC GENERAL CIRCULATION MODELS INCLUDING SUBGRID SCALE SPATIAL VARIABILITY.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
D. Entekhabi, and P. S. Eagleson.
Journal of Climate JLCLEL, Vol. 2, No. 8, p 816-831, August 1989. 11 fig, 1 tab, 19 ref, append.
NASA Grant NAG 5-743.

Descriptors: *Hydrologic models, *Soil moisture, *Precipitation, *Runoff, Mathematical analysis, Circulation patterns.

Parameterizations were developed for the representation of subgrid hydrologic processes in atmospheric general circulation models. Reasonable a priori probability density functions of the spatial variability of soil moisture and of precipitation were used in conjunction with the deterministic equations describing basic soil moisture physics to derive expressions for the hydrologic processes that include subgrid scale variation in parameters. The runoff ratio function is based on both the point-excess of rainfall intensity with respect to the local infiltrability, and the precipitation over the saturated area in near-channel zones and depressions. The bare soil evaporation efficiency is based on desorption physics for drying porous media. Extensions of the transpiration efficiency for a multiple layer soil system are established based on simple assumptions concerning the moisture states of soil layers for the same hydrologic subareas. The general circulation model computations may be generally subdivided into dynamical and physical parameterizations. The physical parameterizations often require the consideration of processes on scales smaller than those sufficient for dynamical computations. (White-Reimer-PTT)
W90-01957

COLD FRONTAL RAINBAND OBSERVED DURING THE LANDES-FRONTS 84 EXPERIMENT: MESOSCALE AND SMALL-SCALE STRUCTURE INFERRED FROM DUAL-DOPPLER RADAR ANALYSIS.
Centre de Recherches en Physique de l'Environnement, Issy-les-Moulineaux (France).
Y. Lemaitre, G. Scialom, and P. Amayenc.
Journal of the Atmospheric Sciences JAHSAK, Vol. 46, No. 14, p 2215-2235, July 15, 1989. 20 fig, 39 ref.

Descriptors: *Weather patterns, *Satellite technology, *Precipitation, *France, Doppler radar, Weather data collections, Rainbands, Airflow, Frontal dynamics.

The kinematic structure of a cold frontal rainband with a secondary cold front which moved over southwest France on 4 June 1984 was observed during the French cooperative field experiment using LANDES-FRONTS 84. Data used in this study have come primarily from dual Doppler radar, upper air soundings, surface meteorological mesonetwork and satellite imagery. The mesoscale reflectivity field is characterized by a 80 km-wide rainband oriented along the surface front and normal to the vertical shear of the horizontal wind with precipitation cores (spaced 30-40 km apart) elongated in the direction of this shear. It appears that both synoptic ascent (Warm Conveyor Belt), slantwise convection along the tilted frontal zone and upright convection in the first 10 km at the leading edge of the system are present. The characteristics of the rainband are analyzed in terms of the relevant dynamical mechanisms, including: (i) the frontogenetical forcing of the prefrontal boundary layer air by the low level cold flow acting at small scale as a gravity current; (ii) the mesoscale organization of precipitation by the conditional symmetric instability which develops inside the Warm Conveyor Belt; and (iii) the release of the convective instability in altitude within the rearward inflow along the frontal surface. In order to assess impacts on frontal dynamics, mesoscale motions and experimental mesoscale descriptions of the 3D airflow are needed. (Author's abstract)
W90-01958

SELF-CONSISTENCY APPROACH TO IMPROVE MICROWAVE RAINFALL RATE ESTIMATION FROM SPACE.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 7B.
W90-01989

TWO AUTOMATED METHODS TO DERIVE PROBABILITY OF PRECIPITATION FIELDS OVER OCEANIC AREAS FROM SATELLITE IMAGERY.
Canadian Meteorological Centre, Dorval (Quebec).
L. Garand.
Journal of Applied Meteorology JAMOAX, Vol 28, No. 9, p 913-924, Sep 1989. 4 fig, 7 tab, 19 ref.

Descriptors: *Remote sensing, *Precipitation, *Marine climates, *Satellite technology, Statistical methods, Automation, Clouds.

Two methods of deriving probability of precipitation fields (PP) over oceanic areas are presented and compared. The cloud fields are analyzed at the scale of approximately 130-150 km from satellite visible and infrared imagery and collocated with ship observations of present weather. Method 1 is based on a detailed cloud classification scheme in 20 classes: a mean PP is determined for each cloud class. Method 2 assigns a PP based on cloud top temperature and mean cloud albedo only. For both methods, a normalization with respect to cloud fraction is applied. Method 1 involves more cloud field descriptors than Method 2, but the latter is simpler to implement and much faster. The PPs assigned to individual cloud fields vary between 0% and 65%. The importance of the visible sensor is clearly demonstrated, i.e., infrared-only techniques will be much less accurate. For real-time applications, the two methods provide similar results except for some specific cloud classes where maximum differences reach 13%, due to the lower level of classification used in Method 2. On a monthly time scale, the absolute accuracy of both methods is about 1.2% rms, based on independent data taken during the winters of 1984 (1064 samples) and 1986 (673 samples) over the northwestern Atlantic. From the 3 months for which PP maps are produced, the average local variability between months is 4.8% rms. It follows that the PP variance between months is typically 16 times larger than the error variance of the satellite estimates. Thus both methods provide a reliable precipitation indicator. (Author's abstract)
W90-01990

CLIMATIC SUMMARY OF SNOWFALL AND SNOW DEPTH IN THE OHIO SNOWBELT AT CHARDON.
Kent State Univ., OH. Dept. of Geology.
For primary bibliographic entry see Field 2C.
W90-02003

NUMERICAL SIMULATION OF AN INTENSE SQUALL LINE DURING 10-11 JUNE 1985 PRESTORM. PART II: REAR INFLOW, SURFACE PRESSURE PERTURBATIONS AND STRATIFORM PRECIPITATION.
National Center for Atmospheric Research, Boulder, CO.
D.-L. Zhang, and K. Gao.
Monthly Weather Review MWREAB, Vol. 117, No. 9, p 2067-2094, September 1989. 21 fig, 39 ref.

Descriptors: *Meteorology, *Atmospheric physics, *Squalls, *Model studies, Simulation analysis, Sensitivity analysis, Air masses, Precipitation.

Phenomena associated with a squall line were examined using a three-dimensional mesoscale nested-grid model. It was found that large-scale baroclinity provides favorable and deep rear-to-front flow within the upper half of the troposphere and the mesoscale response to convective forcing helps enhance the trailing extensive rear inflow. However, latent cooling and water loading are directly responsible for the generation of the descending portion of the rear inflow. As considerable mass within the rear inflow subsides, an intense surface wake low is formed at the back edge of the squall system. In this case study, the rear-

inflow jet appeared to have caused the splitting of the surface wake low as well as the organized rainfall. The simulation showed that the squall line initially leans downshear and later upshear as the low-level cold pool progressively builds up and the system moves into a convectively stable environment. Several sensitivity experiments were conducted. The generation of the descending rear inflow, and the surface and midlevel pressure perturbations were found to be most sensitive to the parameterized moist downdrafts, hydrostatic water loading, evaporative cooling, and ice microphysics, in that order. Without any one of these model processes, the rear inflow does not reach the surface and the surface mesohigh and wake low do not become well developed. The results illustrate that the descending rear inflow is a product of the dynamic response to the latent-cooling-induced circulation. (Author's abstract)
W90-02130

MICROMETEOROLOGY OF TEMPERATE AND TROPICAL FOREST.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 4D.
W90-02150

IMPACT OF FORESTS ON MESOSCALE METEOROLOGY.
Centre National de Recherches Meteorologiques, Toulouse (France).
For primary bibliographic entry see Field 4C.
W90-02151

ANALYSIS OF SUMMERTIME CLOUD WATER MEASUREMENTS MADE IN A SOUTHERN APPALACHIAN SPRUCE FOREST.
Tennessee Valley Authority, Muscle Shoals, AL. Atmospheric Science Dept.
For primary bibliographic entry see Field 5A.
W90-02155

CIRCULATION REGIMES OF RAINFALL ANOMALIES IN THE AFRICAN-SOUTH ASIAN MONSOON BELT.
Wisconsin Univ.-Madison. Dept. of Meteorology.
U. S. Bhatt.
Journal of Climate JLCLEL, Vol. 2, No. 10, p 1133-1144, October 1989. 6 fig, 1 tab, 27 ref. NSF grant ATM-8722410 and NOAA grant NA86AAD-AC064.

Descriptors: *Meteorology, *Climatology, *Rainfall, *Monsoons, *Air circulation, *Hydrometeorology, *Stream discharge, Subsaharan Africa, South Asia, Monte Carlo method.

The spatial differentiation of climate anomalies and associated circulation mechanisms across the African-South Asian monsoon belt was examined through empirical analyses, mainly for the period 1948-83. Observations include surface ship observations in the tropical Atlantic, eastern Pacific, and Indian oceans, and various hydrometeorological and circulation index series, representing the water discharge of the Senegal River (SENEGAL), the rainfall in the West African Sahel (SAHEL), the discharge of rivers in the Nile basin (ROSEIRES, ATBARA), the Indian monsoon rainfall (NIR), and the Southern Oscillation (SO). The field significance of correlation patterns was ascertained through Monte Carlo experiments. There is a strong correlation of hydrometeorological conditions from Senegal to the Sahel, a decrease from each of these domains eastward to the Nile catchment, and even more so to India. Conversely, correlations are remarkably high between the water discharge of the Nile basin and Indian rainfall. An SO index was correlated positively with the hydrometeorological conditions throughout the monsoon belt, but most strongly in the East (NOR) and least in the West (SENEGAL). Correlation analyses for the July-August height of the boreal summer monsoon indicate that abundant rainfall in the western Sahel is, in the Atlantic sector, associated with weak northeast trades and in the western Indian Ocean with low pressure overlying cool surface waters. By comparison, copious river discharge in the eastern portion of the Subsaharan zone coincides with weakened northeast trades over the Atlantic but more pronounced circulation departures in the Indian Ocean sector, consisting of anomalously low pressure, cold surface waters, and abundant cloudiness in the northern Indian Ocean. This ensemble of atmosphere-ocean anomalies is also characteristic of abundant Indian monsoon rainfall. During the positive SO phase, rainfall tends to be relatively abundant throughout the monsoon belt, but most markedly so in the eastern portion of Subsaharan Africa and in India. Overall, the western Sahel shows the strongest associations with circulation departures in the tropical Atlantic, whereas the eastern portion of Subsaharan Africa and India are more closely related to the circulation of the Indian Ocean sector. (Author's abstract)
W90-02179

MIST AND FOG INTERCEPTION IN ELFIN CLOUD FORESTS IN COLOMBIA AND VENEZUELA.
Universidad de Los Andes, Merida (Venezuela). Dept. de Biologia.
For primary bibliographic entry see Field 2I.
W90-02206

PROCESSES CONTROLLING THE CONCENTRATIONS OF SO4(--), NO3(-), NH4(+), H(+), HCOO-T AND CH3COO-T IN PRECIPITATION ON BERMUDA.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W90-02218

NA(+)/CL(-) RATIOS IN RAIN ACROSS THE USA, 1982-1986.
Arkansas Univ., Fayetteville. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W90-02219

ORIGIN OF ARCTIC PRECIPITATION UNDER PRESENT AND GLACIAL CONDITIONS.
Iceland Univ., Reykjavik. Science Inst.
S. J. Johnsen, W. Dansgaard, and J. W. C. White.
Tellus TELLAL, Vol. 41B, No. 4, p 452-468, September 1989. 13 fig, 1 tab, 37 ref.

Descriptors: *Climatology, *Precipitation, Snow, Arctic, Ice sheet, Seawater, Evaporation, Sublimation, Glacial climates, Deuterium excess, Kinetics, Model studies, Seasonal variation, Greenland, North Atlantic Ocean.

At low altitude locations, the deuterium excess d=deltaD-8Delta-O-18 in precipitation generally varies with the season in antiphase with the deltas. In the high-altitude regions of the Greenland ice sheet, however, d in the snow varies with only a few months time lag behind the delta's. A model for the d values in Greenland precipitation is developed on the basis of Rayleigh condensation/sublimation with due account taken of kinetic effects during both evaporation of sea water and sublimation. The model predicts that the initial mixing ratio w50 in precipitating air determines the slope of the d versus delta relationship at late stages of the precipitation process, and that the sea surface temperature, Ts, in the source area of the moisture only influences the d level. The generally high d-values in ice sheet precipitation are compatible only with high values of w50 and Ts, which suggests the subtropical part of the North Atlantic Ocean as a dominating moisture source for ice sheet precipitation. This is supported experimentally; when the model is run with monthly w50 and Ts mean values observed at Ship E (35 deg N, 48 deg W), it reproduces the high d level, the amplitude of the seasonal d variations, and the few months phase difference between d and delta on the ice sheet. None of these features can be reproduced with a local, high-latitude moisture source. Detailed isotope analyses of ice core increments, spanning several abrupt climatic shifts under glacial conditions, show close to present d values during the cold phases, but lower d values during the mild phases. (Author's abstract)
W90-02220

EXPONENTIAL POLYNOMIAL MODEL (EPM) OF YIELD FORECASTING FOR SPRING WHEAT BASED ON METEOROLOGICAL FACTORS AND PHENOPHASE.
Akademia Rolnicza, Wroclaw (Poland). Faculty of Land Reclamation and Improvement.
L. Kuchar.
Agricultural and Forest Meteorology AFMEEB, Vol. 46, No. 4, p 339-348, June 1989. 3 fig, 1 tab, 18 ref.

Descriptors: *Meteorology, *Rainfall, *Temperature, *Crop yield, Soil water, Precipitation, Poland, Model studies, Weather, Yield forecasting.

The exponential polynomial model (EPM) is a model of yield forecasting based on meteorological data, prepared for spring wheat. The model has been adapted for the special condition of high variability in yield both temporally and spatially. The two-stage EPM first uses a weather-crop equation and then a yield-forecasting procedure. The model requires total rainfall and mean temperatures before and during the vegetation period for each phenological stage. The water factor in the model may be used in the following forms: (1) total precipitation from October 1 or December 1 to the physiological end of vegetation; (2) soil moisture during the vegetation period sowing to full ripeness; and (3) the sum of soil water at the beginning of vegetation and the total precipitation during the period sowing to full ripeness. The yield predictions were made for the vegetation at any given phenological stage (date of observation of phenological stage, using standard methods) given current data. Model validation showed the method correctly evaluated the weather-crop system, ensuring the correct forecast of yields in different parts of Poland. (Author's abstract)
W90-02226

DETERMINATION OF NITROPHENOLS IN RAIN AND SNOW.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W90-02267

EXPERIMENTAL AND THEORETICAL STUDIES ON MASS TRANSFER IN AN ARTIFICIAL RAIN (EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNGEN ZUM STOFFUEBERGANG AN EINEM KUENSTILCHEN REGEN).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 5B.
W90-02282

PRECIPITATION: PROCESS AND ANALYSIS.
Saint David's Univ. Coll., Lampeter (Wales). Dept. of Geography.
G. Sumner.
John Wiley and Sons, New York. 1988. 455 p.

Descriptors: *Precipitation, *Meteorology, *Climatology, Atmospheric water, Clouds, Cloud liquid water, Local precipitation, Orographic precipitation, Tropical storms, Rain gages, Remote sensing.

The three main components of precipitation study include: meteorology, the origins of precipitation and the processes producing it; its climatology, the organization of precipitation in time and space; and the methodology and philosophy of its measurement and basic analysis. An attempt is made to integrate these three components in a text aimed at students of geography and environmental sciences. Chapters discuss: water in the atmosphere; the formation of clouds; precipitation formation; local and small-scale precipitation; synoptic-scale precipitation--temperate systems; synoptic-scale precipitation--tropical systems; precipitation measurement and observation; precipitation analysis in

time; and precipitation analysis in space. (Lantz-PTT)
W90-02287

SOME APPLICATIONS OF REMOTE SENSING OF CROP-HAIL DAMAGE IN THE INSURANCE INDUSTRY.
Illinois State Water Survey, Urbana.
For primary bibliographic entry see Field 7B.
W90-02296

2C. Snow, Ice, and Frost

CLIMATIC SUMMARY OF SNOWFALL AND SNOW DEPTH IN THE OHIO SNOWBELT AT CHARDON.
Kent State Univ., OH. Dept. of Geology.
T. W. Schmidlin.
Ohio Journal of Science OJSCA9, Vol. 89, No. 4, p 101-108, Sep 1989. 6 fig, 3 tab, 26 ref.

Descriptors: *Climatology, *Ohio, *Snow, *Snow depth, Climatic data, Correlation analysis.

Snowfall records were examined for the period 1945-85 at Chardon, OH, the only station with a long climatic record in the snowbelt. Average seasonal snowfall was 269 cm (106 in) with a seasonal maximum of 410 cm (161 in). Seasonal snowfall was positively correlated with other sites in the lower Great Lakes snowbelts and along the western slope of the Appalachians from Tennessee to Quebec, but was not correlated with snowfall in the snowbelts of the upper Lakes. The time series of seasonal snowfall was not random but showed weak year-to-year persistence. The average number of days with 2.5 cm (1 in) of snowfall was 35. The average dates of the first and last 2.5 cm snowfalls of the winter were 10 November and 4 April. The largest two-day snowfall of the winter averaged 33 cm. The average number of days with 2.5 cm of snow cover was 82. Daily probability of snow cover reached the seasonal maximum of 86% in mid-January and early February. These results may be reasonably extrapolated throughout the Ohio snowbelt for applications in vegetation studies, animal ecology, hydrology, soil science, recreation, and transportation studies. (Author's abstract)
W90-02003

COMPARISON OF SOIL FREEZING CURVE AND SOIL WATER CURVE DATA FOR WINDSOR SANDY LOAM.
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 2G.
W90-02199

GRAZING AND SEDIMENTATION OF ICE ALGAE DURING AND IMMEDIATELY AFTER A BLOOM AT THE ICE-WATER INTERFACE.
Laval Univ., Quebec. Dept. de Biologie.
For primary bibliographic entry see Field 2L.
W90-02210

ORIGIN OF ARCTIC PRECIPITATION UNDER PRESENT AND GLACIAL CONDITIONS.
Iceland Univ., Reykjavik. Science Inst.
For primary bibliographic entry see Field 2B.
W90-02220

CHANGES IN SOIL AND STREAM HYDROCHEMISTRY DURING PERIODS OF SPRING SNOWMELT AT A PRISTINE SITE IN MIDNORWAY.
Macaulay Land Use Research Inst., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.
W90-02263

APPROPRIATE PROBABILITY DISTRIBUTIONS FOR FREEZE-UP EVENTS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
G. R. Alger, H. S. Santeford, and J. A. Harvey.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 305-309, 1 tab, 6 ref.

Descriptors: *Flood peak, *Freeze-thaw tests, *Ice cover, *Probability distribution, *Flood frequency, River forecasting, Water level, River flow, Flood stages, Backwater, Annual floods, Runoff, Flood flow, Michigan.

There are a number of problem situations which require engineers and planners to have knowledge of water levels and water level expectancy or frequency. A freeze-up event, the condition which develops when a river begins to form an ice cover, is a situation which affects magnitude and frequency of river water levels but which is not runoff-related. Six river reaches located in the central and western upper peninsula of Michigan were selected for a study. The Log Pearson III probability distribution is a reasonable distribution to use in estimating annual peak flood stages that can be expected at freeze-up. This technique is acceptable within the limits of data used. Much additional data, i.e., years of record, are required to generate a viable argument for or against the stated conclusion. Backwater due to freeze-up events can be a problem of very large magnitude in site-specific locations on a river--in some cases surpassing the flood of record on a frequent basis. Conventional flood flow frequency analysis should be expanded to accommodate potential freeze-up events. (See also W90-02368) (Fish-PTT)
W90-02405

KARST DEVELOPMENT IN PERMAFROST REGIONS OF NORTHERN CANADA.
Carleton Univ., Ottawa (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2J.
W90-02470

2D. Evaporation and Transpiration

ESTIMATING POTENTIAL EVAPOTRANSPIRATION: THE EFFECT OF RANDOM AND SYSTEMATIC ERRORS.
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
S. J. Meyer, K. G. Hubbard, and D. A. Wilhite.
Agricultural and Forest Meteorology AFMEEB, Vol. 46, No. 4, p 285-296, June 1989. 3 fig, 1 tab, 13 ref. National Climate Program Office Grant No. 87-123-032-01.

Descriptors: *Evapotranspiration, *Evapotranspiration potential, *Error analysis, *Nebraska, Estimating equations, Measuring instruments, Simulation, Meteorological data collection, Humidity, Temperature, Wind, Solar radiation, Growing season.

Random and systematic errors, inherent in meteorological measurements, affect the values of variables used to estimate potential evapotranspiration (ETp). A simulation approach was used to study the effect of the magnitude of those errors on daily ETp estimates over the course of a growing season. Previous attempts to quantify the effect of errors in those variables have been conducted using only 24 h of data. In this study, daily ETp was calculated with the Penman method using data collected at four locations in Nebraska during the 1985 growing season. These ETp values were compared to estimates made after introducing random and systematic errors to the input data. Errors in ETp estimates were progressively larger for errors introduced into the wind run, temperature, humidity, and radiation data leading to the conclusion that accuracy and calibration of humidity and radiation sensors is more critical than wind run and temperature in the Central High Plains of the U.S. (Author's abstract)
W90-02225

2E. Streamflow and Runoff

MODELING BULK ATMOSPHERIC DRAINAGE FLOW IN A VALLEY.
National Oceanic and Atmospheric Administration, Oak Ridge, TN. Atmospheric Turbulence and Diffusion Div.
R. J. Dobosy.
Journal of Applied Meteorology JAMOAX, Vol 28, No. 9, p 936-947, Sep 1989. 6 fig, 3 tab, 21 ref. Contract DE-AC05 760R00033 between the DOE and Oak Ridge Associated Universities.

Descriptors: *Runoff, *Drainage patterns, *Flow measurement, *Model studies, Hydrologic data collections, Numerical analysis, Valleys, Path of pollutants.

Most simulations of bulk valley-drainage flows depend heavily on parameterizations. The 1984 Atmospheric Studies in Complex Terrain (ASCOT) field experiment in Brush Creek Valley, Colorado, provided an unprecedented density of measurements in a natural valley of simple shape, allowing tests of assumptions and parameterizations developed from laboratory measurements and detailed numerical simulations. This paper uses the ASCOT data to test a model that computes total fluxes of mass (volume) and momentum--determining buoyant and pressure-gradient forces from measured temperature profiles, and parameterizing drag, entrainment, and sidewall and tributary drainage. Computed divergences of volume and momentum flux are within a factor of 2 of the Doppler lidar measurements in Brush Creek Valley. A major problem for future work is the treatment of the interaction between valley drainage and ambient flow. Applications include initial response to an accidental release of hazardous materials, preliminary assessment of pollutant transport in complex terrain, and parameterization of drainage patterns too small to resolve in mesoscale numerical models. (Shidler-PTT)
W90-01991

INFLUENCE OF WATER QUALITY ON MACROINVERTEBRATE COMMUNITY RESPONSES TO COPPER IN OUTDOOR EXPERIMENTAL STREAMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5C.
W90-02032

MODELLING WATER QUALITY OF A REREGULATED STREAM BELOW A PEAKING HYDROPOWER DAM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 5G.
W90-02044

TRICHOPTERA, AND EPHEMEROPTERA AS INDICATORS OF ENVIRONMENTAL CHANGES OF THE RHONE RIVER AT LYONS OVER THE LAST TWENTY-FIVE YEARS.
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
For primary bibliographic entry see Field 6G.
W90-02045

COMPARISON OF MACROBENTHOS IN BRAIDED AND CHANNELIZED SECTORS OF THE DROME RIVER, FRANCE.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
For primary bibliographic entry see Field 6G.
W90-02050

RIVER BASIN MANAGEMENT IN SCOTLAND.
Clyde River Purification Board, East Kilbride (Scotland).
For primary bibliographic entry see Field 5G.

W90-02087

RIVER BASIN MANAGEMENT IN NORTHERN IRELAND.
Department of the Environment for Northern Ireland, Belfast. Water Service - Eastern Div.
For primary bibliographic entry see Field 5G.
W90-02088

BEHAVIOR OF THE INSECTICIDES DISULFOTON AND THIOMETON IN THE RHINE RIVER: A CHEMODYNAMIC STUDY.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W90-02140

REACTIVE IRON TRANSPORT IN AN ACIDIC MOUNTAIN STREAM IN SUMMIT COUNTY, COLORADO: A HYDROLOGIC PERSPECTIVE.
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 2K.
W90-02173

RISK EQUIVALENT SEASONAL WASTE LOAD ALLOCATION.
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5E.
W90-02186

CHANGES IN THE CHEMICAL COMPOSITION OF STREAM WATER IN TWO CATCHMENTS IN THE SHENANDOAH NATIONAL PARK, VIRGINIA, IN RESPONSE TO ATMOSPHERIC DEPOSITION OF SULFUR.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-02187

SOURCES OF ACIDIC STORM FLOW IN AN APPALACHIAN HEADWATER STREAM.
Pennsylvania State Univ., University Park. Program in Ecology.
For primary bibliographic entry see Field 5B.
W90-02192

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 1. DERIVATION OF A DYNAMIC MODEL.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-02195

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 2. APPLICATION OF MODEL IDENTIFICATION TO THE RIVER MURRAY.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-02196

LIFE HISTORY, ECOLOGY AND POPULATION STATUS OF MIGRATORY BULL TROUT (SALVELINUS CONFLUENTUS) IN THE FLATHEAD LAKE AND RIVER SYSTEM, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
For primary bibliographic entry see Field 2H.
W90-02214

HABITAT FEATURES AND TROUT ABUNDANCE RELATIVE TO GRADIENT IN SOME WYOMING STREAMS.
Forest Service, Fort Collins, CO. Wildlife and Fish Ecology Unit.
For primary bibliographic entry see Field 2H.
W90-02215

ABRUPT DOWNSTREAM FOREST DECLINE FOLLOWING RIVER DAMMING IN SOUTHERN ALBERTA.
Lethbridge Univ. (Alberta). Dept. of Biological Sciences.
For primary bibliographic entry see Field 6G.
W90-02236

ALGOLOGICAL OBSERVATIONS IN WATERS OF BIOSPHERE RESERVATION 'STECKBY-LODDERITZER FORST' (G.D.R.) (ALGOLOGISCHE BEOBACHTUNGEN IN GEWASSERN DES BIOSPHARENRESERVATES 'STECKBY-LODDERITZER FORST' (DDR)).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 2H.
W90-02249

VARIATION IN THE MACROPHYTIC BIOMASS BETWEEN A LENTIC AND A LOTIC SYSTEM IN RELATION TO ABIOTIC FACTORS.
Bhagalpur Univ. (India). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W90-02252

BACTERIOLOGICAL PARAMETERS AND BIOMONITORING OF WATERS: A COMPARISON OF SITES (BAKTERIOLOGISCHE PARAMETER UND BIOMONITORING VON GEWASSERN: EIN STANDORTVERGLEICH).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 5A.
W90-02253

RIVER MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
G. Nicollet.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 39-63, 11 fig, 1 tab, 11 ref.

Descriptors: Stream discharge, *Model studies, *Oil dispersants, *Dispersants, *River flow, *Hydraulic models, *Physical models, Mathematical studies, Sediment transport, Mathematical studies, River beds, Flow profiles, Flow velocity, Water level, Particle size.

Three main issues of river flow models are related in this paper: (1) non-maritime models with fixed bed; (2) sediment transport in rivers; and (3) river models with movable bed. Hydraulic modeling of non-maritime, fixed bed rivers, requires considerations to be made of the following aspects of the model: construction; control and operation; calibration; measurement and instrumentation; flow velocities; water levels; and water pressure. The word 'sediment transport' describes various types of phenomenon, an important parameter being particle size. Experimental observations show that small particles are entirely surrounded by fluid, they are said to move in suspension. When the size of the particles is bigger, the turbulence energy cannot counterbalance gravity and the particles remain in the vicinity of the bed and move by rolling, sliding or jumping. This second kind of sediment transport is commonly referred to as the transport of the bedload. River models with movable beds requires similar considerations to that of the fixed bed model, with some notable exceptions. However, construction of the model, choice of movable bed material for the model, calibration of the model, and operation and measurement, are required for a successful movable bed river model. (See also W90-02358) (Lantz-PTT)
W90-02360

CURRENT AND FUTURE DIRECTION OF THE CORPS OF ENGINEERS WATER RESOURCES PROGRAMS.
Corps of Engineers, Washington, DC.
For primary bibliographic entry see Field 6F.
W90-02369

EFFECT OF ACEC DESIGNATIONS ON PROPOSED DEVELOPMENT IN THE 100-YEAR FLOOD PLAIN.
IEP, Inc., Sandwich, MA.
For primary bibliographic entry see Field 6F.
W90-02374

KISSIMMEE RIVER: FLOODPLAIN HARMONY IN RESTORATION.
South Florida Water Management District, West Palm Beach.
For primary bibliographic entry see Field 4A.
W90-02376

STREAM RENOVATION: A NEW APPROACH TO AGRICULTURAL FLOOD DAMAGE REDUCTION.
Tennessee Valley Authority, Nashville.
For primary bibliographic entry see Field 4A.
W90-02377

TURNING A DITCH BACK INTO A CREEK.
Center for Energy and Environment Research, San Juan, PR.
For primary bibliographic entry see Field 4A.
W90-02378

INCREASING AWARENESS AND UNDERSTANDING OF FLOOD HAZARD AREAS AND FLOOD RISKS THROUGH PRINTED MATERIALS TARGETED TO SPECIFIC INTEREST GROUPS.
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 6F.
W90-02379

NOT ALL FLOODS ARE CREATED EQUAL: TOWARD A COMPREHENSIVE ASSESSMENT OF FLASH FLOODS IN THE UNITED STATES.
Colorado Univ., Colorado Springs.
E. Gruntfest, and C. J. Huber.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 137-143, 17 ref.

Descriptors: *Flash floods, *Flood plain management, *Warning systems, *Planning, *Flood forecasting, Case studies, Surveys, Disasters, Urban planning, Dam failure.

Flash floods officially constitute a small percentage of the number of major disasters; however, many communities are subject to isolated severe storms and suffer disastrous effects. An assessment of national vulnerability to flash floods is underway. A survey of 18 early warning systems from throughout the United States developed by communities or regions to provide protection against flash floods or dam failures indicate that warning systems are seen as a promising means of responding to increased vulnerability to flood losses. Three key recommendations are a need for (1) an understanding of the geographic distribution of the flash flood hazard, (2) an appreciation of how effective flash flood warning systems have been and can be expected to be, and (3) a set of illustrative case studies to be used by local officials in communities vulnerable to flash flood problems. The first step in the assessment is to define flash floods precisely as opposed to slow rise floods. One of the primary reasons that defining flash floods is so difficult is the complexity of the flash flood problem, which exists in a wide variety of locales and regions. (See also W90-02368) (Fish-PTT)
W90-02383

EVALUATING FLOOD HAZARDS ON ALLUVIAL FANS.
Baker (Michael), Jr., Inc., Alexandria, VA.
M. E. Faltas.
IN: Floodplain Harmony. The Natural Hazards

Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 248-253, 4 fig, 3 tab, 6 ref.

Descriptors: *Flood plain management, *Alluvial fans, *Flood flow, *Mapping, *Mathematical models, Hydrodynamics, Regulations, Risks, Water depth, Flow velocity, Statistical analysis, Flow discharge, Discharge frequency, Rainfall-runoff relationships.

The technology of mathematically modeling the hydrodynamics of water and debris flows for unconfined conditions such as flow on alluvial fans is still in the early development stage. The Federal Emergency Management Agency (FEMA) has focused on formulating a mapping procedure for the purpose of defining the likelihood of flood hazards on inundated alluvial fan zones to be used for flood insurance purposes and general flood plain regulation, referred to as the FEMA alluvial fan methodology. The FEMA methodology utilizes an isorisk line concept that relates the alluvial fan arc width to a corresponding flood depth and velocity, using statistical analyses that relate the probability of given discharges at the apex of a fan to the probability of certain depths and velocities of flow occurring at any point on the fan below the apex. The FEMA methodology provides a rational uniform approach for identifying potential hazard areas for undeveloped alluvial fans. The primary assumption in this methodology is that the discharge-frequency distribution at the apex can be estimated accurately. Fan widths corresponding to certain flood hazard zone boundaries are sensitive to the value of the skew coefficient. Small hydrologic sample populations derived by using rainfall-runoff models or statistical analysis of short-term gage data, do not provide a good estimate of the skew; therefore the sample skew should be weighted with regional skew estimates. (See also W90-02368) (Fish-PTT)
W90-02399

DESIGN DEPTHS AND VELOCITIES ON ALLUVIAL FANS.
Baker (Michael), Jr., Inc., Beaver, PA.
E. R. Mifflin.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 254-259, 2 fig, 2 ref.

Descriptors: *Flood plain management, *Flood forecasting, *Water depth, *Flow velocity, *Alluvial fans, Probability distribution, Flood flow, Design floods, Design standards, Mathematical analysis.

Under Federal Emergency Management Agency guidelines, flood depths and velocities on alluvial fans are determined by considering the probability of a given point on the alluvial fan being hit by a flood following an unpredictable path. When determining a design depth and velocity, the size of the proposed project must be considered. As the area of the alluvial fan occupied by the project increases the chances of the project being hit by a given flood increase. A methodology has been developed that uses the size of the area at risk to determine design depths and velocities on alluvial fans. An example is given to illustrate the methodology itself and to demonstrate the different ways that the methodology is applied for flood insurance and design purposes. (See also W90-02368) (Fish-PTT)
W90-02400

CRISFIELD, MARYLAND FLOOD ALLEVIATION AND TIDAL DIKE STUDY.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
For primary bibliographic entry see Field 6F.
W90-02403

APPROPRIATE PROBABILITY DISTRIBUTIONS FOR FREEZE-UP EVENTS.
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2C.
W90-02405

MAPPING INNOVATIONS FOR FLOODPLAIN MANAGEMENT AND ENGINEERING.
Dewberry and Davis, Fairfax, VA.
For primary bibliographic entry see Field 7C.
W90-02406

IS NORMAL HIGH WATER REALLY 'NORMAL'.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
W. W. Hansen.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 315-320, 3 fig, 2 tab, 4 ref.

Descriptors: *Flood plain management, *Water level, *Reservoir capacity, *Flood frequency, High water mark, Ponds, Lakes, Storms, Water level fluctuations, Bankfull stage, Storage capacity, Rainfall, Elevations, Probability distributions, Discharge frequency, Watershed management, Georgia.

The delineation of a Special Flood Hazard Area (SFHA) downstream from a pond, lake, or reservoir is invariably based upon the lake's being at its 'normal' operating level prior to the occurrence of the upstream storm event. In the last few years, however, many reservoirs throughout the southeastern U.S. have been observed to be well below the 'usual' level much more frequently than 'normal.' Under these circumstances, a storm with a frequency in excess of 100-years will produce less extensive flooding than expected due to higher-than-normal flood storage capacity. Conversely, storage levels above 'normal' could produce flooding beyond the SFHA even from a storm of lesser severity than the 100-year event. An analysis of this condition is illustrated by an example drawn from a watershed in Fulton County, Georgia. For a given depth of rainfall upstream of a reservoir, the extent of flooding below the reservoir is affected by the volume of flood storage capacity in the lake. Both the depth of rainfall and the reservoir water-surface elevation at the onset of the storm have their own probability distributions, and the discharge-frequency relation of the reservoir outflow is determined from the probability of the coincidence of the two events which produce a given reservoir outflow rate. (See also W90-02368) (Fish-PTT)
W90-02407

APPLICATION OF FLOODPLAIN MANAGEMENT BY LOCAL GOVERNMENT USING GIS TECHNOLOGY.
Pinellas Park Water Management District, FL.
For primary bibliographic entry see Field 7C.
W90-02408

ANALYSIS OF A HIGH-HAZARD FLOOD ZONE.
Love (David J.) and Associates, Inc., Boulder, CO.
D. J. Love, J. S. McGuire, A. Taylor, and D. Birch.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 330-336, 9 fig, 2 tab, 5 ref.

Descriptors: *Flood plain management, *Flood plain zoning, *Safety, *Stability analysis, Hydraulic models, Hazards, Urbanization, Floodwater, Flow velocity, Water depth, Regulations, Colorado.

The city of Boulder, Colorado, desires to realistically define high hazard in the 100-year flood plain as a means to minimize threats to life and property. In quantifying hazard, a Product Number Zone was investigated as a possible compliment to the Rise Floodway Zone now used by many local, state, and national regulatory agencies. A Rise Floodway Zone addresses the issue of decreased conveyance in the flood plain due to urbanization, while a Product Number Zone deals with hazard to human life due to the direct forces of floodwaters. The Product Number is that combination of average velocity and flood depth which creates instability under given conditions. Considerations in this analysis include body configuration, resultant hydraulic forces, and footing. The Product Number describes an acceptable life safety hazard since it represents a threshold at which instability to humans in flood waters occur. In order to define a consistent and defensible regulatory tool, theoretical and experimental methods were used to explore life safety in the floodway. While experiment has shown that a human subject may be able to withstand a product number as high as 25, conservative practice would dictate the adoption of a product number of four for regulation. (See also W90-02368) (Fish-PTT)
W90-02409

FEASIBILITY OF PREDICTING 100-YEAR FLOODWAY WIDTH AND DEPTH IN THE TENNESSEE VALLEY BY MULTIPLE LINEAR REGRESSION.
Tennessee Valley Authority, Knoxville.
R. H. Mueller.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 337-342, 7 fig, 5 ref.

Descriptors: *Flood plain management, *Flood forecasting, *Floodways, *Regression analysis, *Watershed management, Linear programming, Flood damage, Water depth, Estimating equations, Watersheds, Variability, Tennessee.

One of the most serious impediments to effective administration of local flood damage reduction programs cited by community officials and state National Flood Insurance Program (NFIP) coordinating agencies is the lack of detailed flood data (flood depth and floodway width). The Tennessee Valley Authority is making an effort to develop equations for estimating flood depth and floodway width along natural, unobstructed stream reaches from common watershed characteristics using multiple linear regression. Results show that floodway width cannot be predicted with reasonable accuracy because of the inherent variability of floodway width along a given stream reach. The U.S. Geological Survey and several state agencies have had success developing regional equations for predicting 100-year flood depths. Depth regression equations adequately cover most of the Tennessee Valley. The inherent variability of floodway width discourages use of regional regression equations for predicting floodway width. The need for an easy-to-use method for predicting floodway width remains. (See also W90-02368) (Fish-PTT)
W90-02410

DISSOLUTION-RATES IN SPANISH KARST REGIONS.
P. Garay, F. J. Obarti, and I. Morell.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 276-280. 1 fig, 1 tab, 14 ref.

Descriptors: *Geomorphology, *Geochemistry, *Karst hydrology, *Karst, *Geohydrology, *Spain, Mathematical analysis.

The variability of the dissolution-rates calculated in different types of karst regions in Spain was evaluated using the formulas of Corbel, and Smith and Atkinson. The rates varied between less than 20 cubic m/square km/year for karst developed under semiarid climate to more than 100 cubic m/square km/year for high mountain karst. A good lineal correlation between magnitude of rain and dissolution-rate similar to that found by other investigators worldwide was observed. However, these formulas do not include some important aspects such as the chemical content of rainwater, the Ca-Mg ratio of outside inputs, the porosity

variation, density and heterogeneity of limestone and dolomite, precipitation-redissolution processes inside the karst, etc. Therefore, the results obtained using these formulas must be held only as order-of-magnitude estimates rather than actual values. (See also W90-02444) (Mertz-PTT)
W90-02473

APPLICATION OF FREQUENCY AND RISK IN WATER RESOURCES: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
D. Reidel Publishing Company, Boston, MA. 1987. 502p.

Descriptors: *Flood frequency, *Design floods, *Flood data, *Flood forecasting, *Frequency analysis, *Precipitation, *Floods, Case studies, Mathematical studies, Probabilistic process, Flood control, Flood protection, Rainfall, Project planning, Forecasting, Prediction.

The objectives of this symposium were (1) to assess the current state of the art of flood frequency and risk analysis, (2) to demonstrate applicability of flood frequency and risk models, (3) to establish complementary aspects of seemingly different models, (4) to enhance interdisciplinary interaction, (5) to discuss practice of flood frequency and risk analyses technology by federal agencies in the United States, (6) to discuss research needs in frequency and risk analyses, and (7) to determine directions for further research. This book contains seven sections encompassing major hydrologic applications of frequency and risk analyses. Each section starts with an invited paper, followed by contributed papers. Beginning with a discussion of flood characteristics, the papers go on to discuss design flood, errors and outliers, application in design of water resources projects, risk and reliability analyses, flood damage assessment, and practices of frequency and risk analysis by federal agencies in the United States. (See W90-02508 thru W90-02544) (Stoehr-PTT)
W90-02507

RESEARCH NEEDS ON FLOOD CHARACTERISTICS.
Georgetown Univ., Washington, DC. School of Engineering and Applied Science.
V. Yevjevich, and N. B. Harmancioglu.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A., NSF grant 85-41631. D. Reidel Publishing Company, Boston, MA. 1987. p 1-21. 5 fig, 65 ref.

Descriptors: *Research priorities, *Floods, *Probable maximum precipitation, *Precipitation, *Estimating, Flood control, Flood data, Flood basins, Rainfall-runoff relationships, Rainfall, Risks, Frequency analysis, Maximum probable floods.

Flood risk is nature related and can be changed only by changing the characteristics of floods. Flood uncertainty is investigation related and can be changed only by more observation and investigation. The question to be answered is whether or not there is a physical upper bound to flood magnitude. The concept of probable maximum precipitation (PMP) seems to imply that there is an upper bound to flood magnitude. Flood characteristics are estimated by one or more methods: frequency curves, transfer of information, regional data, paleohydrology, Bayesian and PMF groups of methods. The contemporaneous aspects of analysis of flood characteristics are related to reliability of estimation of floods of small exceedence probabilities in the range .1 to .000001, whether there is an upper bound to floods and whether it is feasible to attach a probability value to probable maximum flood (PMF). To answer these basic questions, three investigation are needed: (1) study of properties of the upper tail of probability distribution of floods; (2) use of regional data for drawing either the envelopes of largest floods or the curves of average largest flood characteristics for given sample sizes in the region, with probabilities attached to these envelopes or average curves; and (3) finding of the composite probability of PMF by studying the aggregated probabilities of random variables which are 'maximized' in the process of computing PMP and PMF. Flood characteristics changes with time due to changes in river basins. The need exists for methods of estimation of flood characteristics over periods of time of 25-100 years, particularly for planning flood mitigation measures over an extended future. (See also W90-02507) (Author's abstract)
W90-02508

APPLICATION OF PROBABLE MAXIMUM FLOOD ESTIMATES TO THE DESIGN OF WATER RESOURCE DEVELOPMENT PROJECTS.
Harza Engineering Co., Chicago, IL.
B. Wang.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 23-33. 14 ref.

Descriptors: *Water resources development, *Dams, *Spillways, *Estimating, *Design floods, *Risks, *Simulation analysis, Rainstorms, Probable maximum precipitation, Maximum probable floods, Hydraulic design, Hydrograph analysis, Hydrographs.

Designs of most major dams and spillways are based on probable maximum floods (PMF). When properly estimated, PMFs provide the basis for confident sizing of spillway. There are, however, many factors which affect the estimation of a PMF. In analyzing each of these factors, certain assumptions have to be made and subjective judgments exercised. The PMF is estimated by transforming a probable maximum precipitation (PMP). Factors involved in determining PMP include critical duration, type of storm, generalized estimates for a specific area, site specific studies, snowmelt, and antecedent and subsequent storms. The PMP is transformed to a PMF by the unit hydrograph method or by a simulation method. Before being adopted for design purposes, the reasonableness of a PMF is often investigated by comparing it with recorded floods. (See also W90-02507) (Stoehr-PTT)
W90-02509

HEAVY RAIN STORM FLOODS IN CHINA AND THEIR ESTIMATION.
East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology.
D. Zhan, and J. Zou.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 35-43. 7 fig, 10 ref.

Descriptors: *Rainfall-runoff relationships, *Rainstorms, *Floods, *China, *Estimating, *Historic floods, Frequency analysis, Maximum probable floods, Probable maximum precipitation, Typhoons, Hydrometeorology, Precipitation, Rainfall.

Four heavy rainstorm systems which resulted in extraordinary floods in China are described. Each had its synoptic features which were different from those of ordinary heavy rainstorms. There is reason to believe that extraordinary floods and frequent and minor floods do not come from the same parent population. In addition, it is difficult to estimate the recurrence interval of historic floods. Therefore, the outliers could hardly match the ordinary floods even if the historic floods were involved. Closely scrutinizing the features of the heavy rain storms, it was found that Probable Maximum Precipitation and Flood (PMP and PMF) estimation is favorable compared with that of frequency analysis. Paleofloods may extend the flood series to as long as 10,000 yr. and provide objective evidence of extraordinary floods. (See also W90-02507) (Author's abstract)
W90-02510

BAYESIAN FRAMEWORK FOR INFERENCE IN FLOOD FREQUENCY ANALYSIS.
Newcastle Univ. (Australia). Dept. of Civil Engineering.
G. Kuczera.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 45-61. 41 ref.

Descriptors: *Flood frequency, *Statistical methods, *Frequency analysis, *Floods, *Prediction, *Bayesian theory, *Reviews, Model studies, Rainfall, Precipitation, Probability distribution, Flood data, Mathematical analysis, Regional floods, Statistical analysis.

One of the major problems facing flood frequency analysis is that predictions typically require extrapolation beyond observed flood experience. Such extrapolations are very much affected by model and parameter uncertainty. This review reflects on the contributions that Bayesian theory has made, and can possibly make, in managing this uncertainty. Some of the issues examined from a Bayesian perspective include the choice of a flood distribution, the exploitation of gauged and historic site information possibly affected by measurement error, development of regional models and the pooling of site and regional information. (See also W90-02507) (Author's abstract)
W90-02511

DEVELOPMENT OF DESIGN PROCEDURES FOR EXTREME FLOODS IN AUSTRALIA.
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
D. H. Pilgrim, I. A. Rowbottom, and D. G. Doran.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 63-77. 3 fig, 5 tab, 15 ref.

Descriptors: *Australia, *Floods, *Design criteria, *Design floods, *Estimating, *Maximum probable floods, *Rainfall, *Data collections, *Dam design, Frequency analysis, Statistical analysis, Meteorological data collection.

Two procedures that have been developed for the estimation of floods of very low probability as part of the revision of 'Australian Rainfall and Runoff', the guide to flood estimation in Australia published by the Institution of Engineers, Australia. A relatively simple procedure for interpolation of floods between the 1 in 100 flood and the PMF was developed after other procedures were shown to be unsatisfactory over a wide range of Australian data. Choice between flood estimates based on design rainfalls and flood frequency analyses is an important design decision. Guidelines for this choice were developed from the statistical characteristics of Australian flood and design rainfall data. (See also W90-02507) (Author's abstract)
W90-02512

DESIGN FLOODS FOR CANAFISTO DAM.
Integral S.A., Medellin (Colombia).
F. Villegas, and J. L. Cadavid.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 79-90. 5 fig, 2 tab, 5 ref.

Descriptors: *Dam design, *Colombia, *Design floods, *Storms, *Spillways, Artificial storms, Estimating, Hydrographs, Hydrograph analysis, Flood flow, Powerplants, River basins, Hydrometeorology, Precipitation, Soil water, Rainfall infiltration.

The process of estimating the design flood for a large dam located on the Cauca River in equatorial Central Columbia is described. The method applied was to estimate an exceptional synthetic storm and consequently, the corresponding hydrograph. Advantage was taken of techniques for evaluating storm potential, developed for temperate latitudes. The peak flow was computed as 28,500 cu m/sec. Because of limitations in the applied procedure it was not possible to assign probability levels to this event. (See also W90-02507) (Author's abstract)
W90-02513

EXPERIENCES OF DESIGN FLOOD OF RESERVOIRS IN MEDIUM AND SMALL BASINS BY THE METHOD OF DESIGN STORM.
Nanjing Hydrological Research Inst. (China).
S. Hua.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 91-100. 7 fig, 3 ref.

Descriptors: *Design floods, *Reservoirs, *Design storms, *Dam design, *Basins, *China, Spatial distribution, Temporal distribution, Hydrographs, Rainfall, Frequency analysis, Earth dams, Developing countries.

Experiences accumulated from the actual design flood of more than eighty thousand reservoirs on the main channel of medium and small basins is described. Most of these dams are earth dams, so it is not permissible for the water to flow over the dam. In China, dam breaks are rarely due to the deviation error of the design flood. This paper introduces the methods of design storm, including its spatial and temporal distribution, and the method of transformation of design storm into design flood hydrographs. Because the complications introduced by the spatial and temporal distribution of design storms lead to uncertainties, an empirical method is preferred. By using a large number of storm events in each climatic region of China, the synthetic analysis and regionalization of storm patterns is more effective and reliable for dam safety. Drainage basins larger than 10,000 sq km should be divided into subsystems before applying empirical methods to obtain acceptable results. (See also W90-02507) (Author's abstract)
W90-02514

ESTIMATION OF DESIGN FLOOD.
I and P (WB) Dn. II, IDUP, Roorkee, UP, India.
D. K. Gupta, B. N. Asthana, and A. N. Bhargawa.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 101-111. 1 fig, 2 tab, 6 ref.

Descriptors: *Statistical methods, *Design floods, *Estimating, Distribution, Data collections, Hydraulic design, Standard deviation, Probability distribution.

A new class of methods such as SMEMAX Power Transformation, and Modified SMEMAX, has been developed for estimation of design flood using the approach of transforming the skewed distribution of observed data into normal distribution. It has been demonstrated that by these methods skewness practically in all cases reduces to a value very near zero, but in many cases Kurtosis does not reduce to 3. To account for the effect of this residual Kurtosis, the use of a correction factor has been recommended. These methods do not truly transform the skewed data into normal distribution. The complete transformation can be achieved by a proposed transformation called Two Step Power Transformation (TSPT), which is described and demonstrated through its application in a large number of cases. It is capable of converting flood data of any degrees of skewness and kurtosis to a normal distribution. (See also W90-02507) (Author's abstract)
W90-02515

DESIGN FLOOD ESTIMATION FOR NARMADA SAGAR PROJECT USING PARTIAL DURATION SERIES - A CASE STUDY.
National Inst. of Hydrology, Roorkee (India).
N. K. Goel, S. M. Seth, and S. Chandra.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 113-122. 2 fig, 3 tab, 8 ref.

Descriptors: *Design floods, *Estimating, *India, *Floods, *Time series analysis, *Frequency analysis, Hydrographs, Historic floods, Annual floods, Data collections, Sampling, Dams, Case studies.

The details of a study for estimating flood magnitudes of different return periods for Narmada Sagar dam in India, is highlighted, using the partial duration series. The efficiencies of annual and partial flood series were compared on the basis of an exact theoretical approach and an approximate theoretical approach. On the basis of exact theoretical approach it is seen that the partial flood series estimate of T year flood Q(T) always has a smaller sampling variance than that of the annual flood series for a return period T less than 11 years. For any return period the partial flood series estimate of Q(T) has a smaller sampling variance than annual flood series if the average number of peaks per year is at least 1.65. On the basis of approximate theoretical approach, it is observed that in the range studied (1.0 to 2.437) the sampling variance of annual flood series is smaller than that of partial flood series. (See also W90-02507) (Author's abstract)
W90-02516

DESIGN FLOOD COMPUTATION WITH LIMITED DATA - CASE STUDY OF A RESERVOIR IN SUBERNREKHA RIVER BASIN.
Bihar Coll. of Engineering, Patna (India). Dept. of Civil Engineeering.
T. Prasad, and K. Subramanya.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 123-137. 7 tab, 8 ref.

Descriptors: *Design floods, *Case studies, *India, *River basins, *Dam design, *Reservoirs, Estimating, Statistical analysis, Dams, Maximum probable floods, Mathematical studies, Design criteria, Design storms, Hydrographs, Temporal distribution, Rainfall, Developing countries, Kharkai River.

Approaches, methods, techniques and steps adopted in estimating the design floods for a reservoir project having limitations of data with respect to length, reliability and instrumentation, are discussed. Two approaches of defining design floods, the physical or genetic approach and the statistical approach are considered. The various steps in probable maximum flood (PMF) estimation, the deviations from standard techniques, the need for making the deviations and their rationale are described. The exercise, carried out with respect to a World Bank assisted dam project on the Kharkai River in eastern India, serves to demonstrate practically suitable and theoretically justifiable procedures to be adopted in applying standard techniques in design flood computation in a case where the available data and information have various limitations. This case is typical in developing countries and hence the study may be of interest to project planners and designers in these countries. (See also W90-02507) (Author's abstract)
W90-02517

CONFIDENCE INTERVALS FOR DESIGN FLOOD EVENTS UNDER DIFFERENT STATISTICAL FLOOD MODELS.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
F. Ashkar, B. Bobee, and L. Fortier.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 139-164, 34 ref.

Descriptors: *Floods, *Design floods, *Statistical analysis, *Flood control, *Model studies, Data collections, Sampling, Hydrology, Flood damage, Flood data.

In many engineering activities relating to floods one has to use a sample x sub 1,...x sub n of flood data along with a statistical distribution f(x) that approximately fits this sample, in order to estimate a particular extreme flood event x sup p corresponding to a small probability of exceedance 1-p (return period t = 1/1-p)). Although one can never tell with certainty what is the true form of f(x) that represents the flood population, it is common practice to assume that one specific form applies, and to estimate its unknown parameters from the sample values x sub 1,... x sub n. The precision with which the event (or 'quantile') x sub p is estimated, depends on the accuracy with which the parameters of f(x) have been obtained. This precision can be quantified by constructing confidence intervals for x sub p. Since these confidence intervals can contain valuable information, they should be calculated with as much accuracy as possible. In hydrology, however, practitioners have often used simple but inaccurate methods for calculating confidence intervals for x sub p. Some relatively simple techniques found in the mathematical literature can be used for calculating confidence intervals for x sub p that give more accurate results than those commonly used in hydrology. Some useful techniques are described for obtaining confidence intervals for the quantiles of the normal (log Normal), Pearson (log Pearson), Weibull (Gumbel), and Exponential distributions. The problem of constructing confidence intervals is also discussed for x sub p when x sub p is estimated via the partial-duration-series approach, under the assumption that the distribution of the number of flood events arriving in an arbitrary time interval (0, t), is Poissonian, and that of the magnitude of flood, is exponential. (See also W90-02507) (Author's abstract)
W90-02518

USE OF ADDITIONAL HISTORICAL INFORMATION FOR ESTIMATION AND GOODNESS OF FIT OF FLOOD FREQUENCY MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
J. Bernier, J. Miquel, A. Lebosse, and A. Griffet.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 153-164, 5 fig, 3 ref.

Descriptors: *Historic floods, *Frequency analysis, *Model studies, *Design floods, *Flood frequency, Garonne River, Rhone River, Mathematical studies, River basins, Parametric hydrology.

For a more reliable estimation of design floods, it is necessary to take account of sampling and model uncertainties. A better control of the involved errors requires the use of all available historical data. These data are essentially the more or less precise estimations of the few extreme events observed in the past before the regular observation of the river. This information is integrated in the estimation process of classical parametric models such as partial duration curves. The results are associated with their approximate confidence intervals especially in the case of design flood discharge estimation. These confidence intervals constitute a first element for judging the quality of the fit of the models. The importance of the nonparametric estimation of probabilities (sometimes called empirical frequencies) is emphasized taking into account additional historical information for the graphical validation of the model. The confidence intervals of these nonparametric estimations are as important as the previous ones calculated with the parametric models. Both intervals constitute the basis

of a better tool for choosing the most adequate probability distribution for floods on the one hand, and a better appraisal of sampling and model uncertainties on the other hand. For illustration the methods are applicated at two rivers, the Garonne at Agen and the Rhone at Serrieres, France. (See also W90-02507) (Author's abstract)
W90-02519

EXTRAPOLATION ERROR IN FLOOD FREQUENCY ANALYSIS.
Zakir Husain Engineering Coll., Aligarh (India). Dept. of Civil Engineering.
A. Qadar, and M. Muzzammil.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 165-174, 1 fig, 4 tab, 8 ref.

Descriptors: *Floods, *Frequency analysis, *Design floods, *Flood data, *Flood frequency, *India, Historic floods, Hydraulic structures, Flood control, Hydraulic design, Catchment areas, Discharge measurement, Discharge frequency, Hydrology.

The frequency analysis of annual peak flood data one of the widely used methods for estimating frequency floods. The extrapolation of frequency floods is generally avoided due to inadequate data available for such studies. An attempt has been made to study the number of errors involved in extrapolation over sufficiently long periods by using short period series. In order to achieve this aim, flood data available for six gaging stations with varying catchment areas and spread over different regions of the country (India) have been selected for study and analyzed by the most commonly used Gumbel's extreme value distribution using the Least Square Method and the Method of Maximum Likelihood. It has been found that the extent of error in extrapolation does not increase appreciably with the extent of extrapolation but corresponds to the error in selection of sample series. In order to estimate the frequency floods within an error of +or-10%, about 50 years flood record may be essential. (See also W90-02507) (Author's abstract)
W90-02520

EFFECT OF DISCHARGE MEASUREMENT ON THE RESULTS OF FLOOD FREQUENCY ANALYSIS.
East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology.
S. Cong, and Y. Xu.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 175-190, 2 fig, 5 tab, 10 ref.

Descriptors: *Discharge measurements, *Floods, *Frequency analysis, *Mathematical models, *Error analysis, Simulation, Hydrologic data, Flood data, Flood discharge, China, Statistical analysis, Monte Carlo method.

A mathematical model of the discharge measurement error was proposed, verified and calibrated. On the basis of the model, the theoretical effect of the error on the population parameters was analyzed by analytical methods and the sample effect of error on the results of frequency analysis was studied by a Monte Carlo simulation. Results obtained show that in the absence of historical outliers, error effects are small and may be neglected if the magnitude of the error is of ordinary order. When a historical outlier is considered, the results of flood flow frequency analysis can be improved if the error parameter of the outlier is less than 0.3. (See also W90-02507) (Author's abstract)
W90-02521

SOME RESEARCHES ON DETERMINATION OF RETURN PERIOD FOR HISTORICAL FLOOD IN ANALYSIS OF FLOOD FREQUENCY.
Mid-South Design Institute for Hydroelectric Project, MWREP, PRC. Guitang, Changsha, Hunan, China.
M. Li, and Q. Yang.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 191-197, 2 fig, 4 ref.

Descriptors: *Frequency analysis, *Historic floods, *Statistical analysis, *Floods, *Design floods, *Flood frequency, China, Hydrology, Risks, Flood control, Flood damage.

The important effect of historical floods on frequency analysis is discussed. The considerable skewed range of the exceedance frequency of high extraordinary floods may bring about some difficulties for fitting the upper part of the curve. It is suggested that the representativeness of the computed series including observed and historical data be demonstrated through analyzing the magnitude and frequency of highly extraordinary floods which have occurred from previous years to the present. The plotting position for the first terms in computing series should be calculated by using the average return period so as to strengthen the stability of the sample. (See also W90-02507) (Author's abstract)
W90-02522

POTENTIAL AND APPLICATION OF FLOOD FREQUENCY DETERMINATIONS.
Espey, Huston and Associates, Inc., Austin, TX.
L. R. Beard.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 199-205.

Descriptors: *Floods, *Frequency analysis, *Estimating, *Flood frequency, Flood protection, Statistical analysis.

Limitations of uncertainty in estimating flood frequencies and means of minimizing the uncertainty are discussed. The value of reducing uncertainty by improved use of data is discussed in relation to risk of future flooding that cannot be eliminated or reduced except by structural measures. The value and uses of reliability criteria are much misunderstood. An arbitrary safety factor is unfeasible, whereas the concept of expected probability is a logical result of considering uncertainties. This concept has been used to assess impacts of uncertainties in mean and variance of flood values. When it can be extended to include uncertainties in higher order moments, such as the skew coefficient, light might be shed on the reason why extreme events occur that are far beyond any reasonable expectation. Applications of flood frequency estimates in the flood insurance program and in general flood mitigation projects are discussed. Emphasis is placed on the most fundamental use of flood frequency information--assessment of expected damages and benefits of all kinds for various alternative programs of flood management under all possible flood conditions. (See also W90-02507) (Author's abstract)
W90-02523

FLOOD ANALYSES PERTAINING TO DESIGN OF NUCLEAR POWER PLANTS.
Stone and Webster Engineering Corp., Boston, MA.
Y.-C. Chang.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 207-217, 22 ref.

Descriptors: *Frequency analysis, *Flood frequency, *Floods, *Nuclear powerplants, *Regulations, Design criteria, Safety, Economic aspects.

The regulatory requirement of flood analysis as part of the licensing procedure of nuclear power plants is discussed. Flood analyses for three nuclear power stations (Jamesport and Greene County, both in New York, and River Bend on the Mississippi River at River Mile 262) which are representative of the coastal, estuarine, and inland sites are presented. The flood analyses include combinations of events, methodology, and results. Further research is needed to balance the safety and economic goals of nuclear power plants. (See also W90-02507) (Author's abstract)
W90-02524

SOME APPLICATIONS OF FLOOD FREQUENCY AND RISK INFORMATION IN FOREST MANAGEMENT.
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W. F. Hansen.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 219-226, 3 ref.

Descriptors: *Floods, *Frequency analysis, *Risks, *Forest management, *Design floods, *Flood frequency, Forest hydrology, Water resources development, Flood plain management, Hydrology, Mathematical studies, Statistical analysis.

Floods have been responsible for the damage or destruction of numerous forest road, channel, and water diversion structures. Some of the losses are to be expected because it is too costly to design for all circumstances. Other losses occur because of little or no flood design, debris accumulations, slope instability, and poor awareness and understanding of the problem. Some applications of flood frequency and risk information in forest land management, include the analysis of data to determine whether to install a culvert or a bridge on a stream in southwest Oregon, the determination of culvert spacing needs for a road of steep side slopes, and in the design of other stream channel or water diversion structures. A simple approach to refine water resource records to meet local needs is included as a tool to check other flood analyses or provide design assistance. (See also W90-02507) (Author's abstract)
W90-02525

REVIEW OF ADVANCES IN RISK AND RELIABILITY ANALYSIS FOR HYDRAULIC STRUCTURES.
Texas Univ. at Austin. Dept. of Civil Engineering.
L. W. Mays.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 227-262, 12 fig, 37 ref.

Descriptors: *Mathematical analysis, *Hydraulic structures, *Design floods, *Reviews, *Risks, *Stress analysis, Design standards, Hydrology, Engineering, Water resources development, Strength.

Studies on the risk and reliability evaluation of hydraulic structures were reviewed and research areas that need to be explored were identified. Systems to which these evaluation techniques may be applied include levees, storm sewer systems, water distribution systems, culverts, etc. Hydraulic uncertainties originate from the inherent randomness of natural hydrologic processes and are attributed to the simplification of mathematical models in describing natural physical phenomenon, imprecise dimensions of hydraulic structures, and nonuniformity of construction materials. Reliability measures for hydraulic structures are dependent upon the various types of uncertainties that exist in common hydraulic designs. A review of static reliability models based on stress strength analysis includes such factors as risk-reliability definitions, safety factors, the treatment of hydraulic uncertainties and applications of static reliabilitymodels.

Other reliability evaluations include dynamic reliability models, time-to-failure analysis of component reliability, and system reliability models, including fault tree analysis. Two basic procedures for optimal reliability optimization would be:(1) maximize system reliability subject to cost constraints, and (2) minimize cost subject to reliability constraints. Research that still needs to be undertaken includes the following: (1) develop accepted definitions and measures of reliability for various types of hydraulic structures; (2) develop design methods that explicitly generate and evaluate various hydraulic structure designs in terms of their ultimate importance to both the total system cost and the total system risk; (3) develop methods for determining system or network reliabilities for hydraulic structures with many components; and (4) develop optimal-risk-reliability based models for the design of hydraulic structures. (See also W90-02507)(Stoehr-PTT)
W90-02526

FLOOD RISK EVALUATION OF URBAN RIVERS WITH STANDARD EQUI-RISK LINES.
Kinki Univ., Higashiosaka (Japan). Dept. of Civil Engineering.
T. Etoh, A. Murota, and M. Nakanishi.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 263-282, 8 fig, 2 tab, 6 ref.

Descriptors: *Rivers, *Floods, *Rainfall intensity, *Flood control, *Risk analysis, *Storage, *Statistical analysis, *Urban areas, Flood hazard, Prediction, Mathematical analysis, Design floods.

The equi-risk line theory for flood storage facilities with the constant release rule is presented. It is extended to be applicable to storage facilities with the following general storage-release relation: q = a times z prime to the p power, where q is the release discharge, and z prime the volume of stored water. The release rule is characterized by the value of p. The shape parameter of the equi-risk line is expressed in terms of p. A standard equi-risk line for urban flood control systems is proposed, which can be applicable in common within a basin to calculate the necessary and sufficient capacities of any kind of flood control facilities, regardless of their location. Examples of the application of the standard quasi-risk line in practical designs include determining the current risk level, developing counter0lans for further urbanization, estimating necessary capacities of flood storage facilities, and evaluating the benefits of flood controls. (See also W90-02507) (Stoehr-PTT)
W90-02527

EVALUATION OF FINANCIAL RISK.
Institute of Hydrology, Wallingford (England).
M. Beran.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 283-291, 2 fig, 2 tab, 3 ref.

Descriptors: *Risks, *Design floods, *Hydrology, *Economic aspects, *Floods, *Simulation analysis, *Flood protection, Flooding, Flood control, Storage, Data acquisition.

Risk in hydrological design is often based on the return period of the design flood. This measures the average interval between events and hence presents only a partial picture. A method of assessing financial risk is presented which recognizes the potentially greater impact of flooding which occurs near the start of a project's life or in proximity to a preceding flood. The fundamental concept is that of a flood-fighting fund. The fund starts with an initial capital which in time accrues interest. In years when flooding occurs the fund is depleted to pay for agricultural losses caused by the inundation. Attention focuses on the size of the capital sum which will reduce the risk of extinction of the fund to an acceptable level within some specified design horizon. The practical utility of the method is illustrated using a recent UK case where floodplain storage was to be provided to alleviate downstream urban flooding. The financial risk concept was used to arrive at a fair level of compensation for occupants of the area to be flooded. Parallels are drawn with insurance risk and the further applicability of the technique to conventional flood protection schemes is discussed. In such cases, the flood risk is reduced but at a price. This price could be used as an initial capitalization for a flood fund and the implied financial risk evaluated for the proposed project. (See also W90-02507) (Stoehr-PTT)
W90-02528

UNCERTAINTIES IN FLOOD PLAIN MAPPING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
B. W. Oegema, and E. A. McBean.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 293-303, 2 fig, 6 tab, 12 ref.

Descriptors: *Mapping, *Flood plains, *Statistical analysis, Flood hazard, Probability distribution, Case studies, Discharge measurement, Mathematical studies, Hydraulic models, Channel flow, Standard deviation, Hydrology, Design floods.

Two of the sources of uncertainty associated with the delineation of floodplains, those of estimation of design discharge and channel capacity, were examined via the joint probability distribution. The uncertainty of the channel capacity is determined using first-order uncertainty analysis of Manning's equation. The variation of the flow area, wetted perimeter, and the friction slope, are expressed in terms of the variances of vertical, lateral, and longitudinal measurements. The variations of Manning's n is characterized by a triangular distribution. The uncertainty information is used to derive confidence limits for the water surface elevation of a flood of a given return period for a channel. In a case study application to the Grand River, Ontario, the standard deviation due to the two sources of error was estimated as 0.50 meter. (See also W90-02507) (Author's abstract)
W90-02529

PROJECT RISK CONSIDERING SAMPLING UNCERTAINTIES AND A FINITE PROJECT OPERATION PERIOD.
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
U. Lall.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 305-318, 8 fig, 1 tab, 28 ref.

Descriptors: *Risk analysis, *Project planning, *Flood control, *Flood frequency, *Frequency analysis, *Design floods, Hydrology, Flood hazard, Economic aspects, Mathematical studies, Statistical analysis.

The risk or probability of failure associated with a flood control project is a random variable, even if perfect information, rather than sample estimates of flood frequency are used for the design process. Procedures are presented for the estimation of the expected value of this risk and its distribution where the flood control project has a finite operation period. Of interest are both the variability of the flood process during project operation and uncertainties inherent in the flood frequency estimation process. The traditional design procedure for flood control projects considers a finite project operation period, as far as the amortization of economic values is concerned. No analysis on the likely exceedance of the design magnitude during an actual run of events in a finite duration, is however considered. As far as the likelihoods of project failure are concerned, the project operation period is thus implicitly considered to be infinite. Design choices are likely to be quite different where the likelihood of project failure during a specified period (over a certain random set of future events) is considered. Where a finite operation period is considered and flood frequency relationships are estimated from annual maximum flow records, the probability of one or more exceedances of the design level is a function of the sample size for estimation and the length of the project operation period. General procedures in a Bayesian framework for the estimation of this probability are presented. (See also W90-02507) (Author's abstract)
W90-02530

OPTIMAL PLANNING OF FLOOD CONTROL SYSTEMS BASED ON RISK ANALYSES OF FLOOD INUNDATION.
Gifu Univ. (Japan). Dept. of Civil Engineering.
T. Kojiri, S. Ikebuchi, and T. Hori.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 319-333, 5 fig, 4 tab, 9 ref.

Descriptors: *Flooding, *Flood control, *Floods, *Planning, *River basins, *Project planning, Hydraulic structures, Rainfall, Simulation analysis, Flow discharge, Case studies, Statistical analysis.

A study was conducted to establish the optimal flood control system which would account for the comprehensive criteria available for on the whole river basin. For a system consisting of multiple sub-basins and multiple reference points, the effects of flood control projects on the flood inundation probability in time and space examined. Project planning is divided into two parts: (1) the site and scale problems; and (2) the scheduling problem. These problems are formulated through the screening model, the simulation model and the sequential model in order to be optimized by using the Experimental Planning Method, and the Dynamic Programming, Branch-bound Method. (See also W90-02507) (Author's abstract)
W90-02531

APPLICATION OF SYSTEM RELIABILITY ANALYSIS TO FLOOD FORECASTING.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
C. S. Melching, H. G. Wenzel, and B. C. Yen.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 335-350, 5 fig, 1 tab, 23 ref.

Descriptors: *Systems analysis, *Flood forecasting, *Model studies, *Rainfall-runoff relationships, *Hydrologic models, *Statistical analysis, *Rainfall, Flood frequency, Hydrology.

The decision making process regarding the issuance of flood watches and warnings often relies on the use of real-time flood forecasting models for watersheds. The floods predicted by these models are subject to uncertainties which may be significant for efficient operation of flood warning and preparedness systems. System reliability analysis offers a means to account for the uncertainties in the flood forecast in the form of occurrence probabilities for any flood level of interest. The advanced first-order second moment (AFOSM) reliability analysis method was used to analyze the uncertainties in a rainfall-runoff flood frequency model proposed by Eagleson (1972) and extended by Wood (1976) for an analytical derivation of the expected flood exceedance probability considering parameter uncertainty. Comparison of the results shows that the AFOSM method is a viable, reasonable, and practical method useful for hydrologic problems subject to uncertainties. (See also W90-02507) (Author's abstract)
W90-02532

STOCHASTIC APPROACH TO FLOOD DAMAGES ESTIMATION.
Montreal Univ. (Quebec). Centre de Recherche de Developpment en Economique.
P. Ouellette, N. El-Jabi, and J. Rousselle.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 351-360, 3 fig, 3 tab, 6 ref.

Descriptors: *Stochastic hydrology, *Floods, *Flood damage, *Costs, *Flood plain management, *Flood flow, Project planning, Mathematical analysis, Flood control, Economic aspects, Estimating, Hydrographs.

Effective flood plain management requires estimation of the costs and benefits of all contemplated projects. A study was conducted on estimating the benefits of such schemes. Starting from the similarity between flood flow and flood damage time series, a probabilistic approach was taken to flood damage estimation. A hydroeconomic model was developed to assess flood-related damages and then a damage distribution function was derived by applying the theory of extreme values and the sum of the random variables to the estimated damage series. It was assumed that the values of extreme damages are independent and identically distributed over the time interval (0,t) of one year and one season simultaneously. The distribution function can then be used to estimate the benefits of flood plain management projects. The Richelieu River basin has been used for a numerical application because of its combined rural and urban characteristics and the fairly large amount of information acquired through previous studies. (See also W90-02507) (Author's abstract)
W90-02533

FLOOD HAZARD ASSESSMENT ON ALLUVIAL FANS: AN EXAMINATION OF THE METHODOLOGY.
Nevada Univ., Las Vegas. Center for Water Resources Research.
R. H. French.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 361-375, 2 fig, 4 tab, 24 ref. Department of Energy Contract DE-AC08-81NV10162.

Descriptors: *Channel morphology, *Flood damage, *Flood forecasting, *Alluvial fans, *Rivers, *Flash floods, Channels, Urban areas, Flood flow, Hydraulic engineering, Soil types, Mathematical analysis, Slopes, Flow rates, Model studies.

The recognition and assessment of the hazard that flash floods can pose to structures located on alluvial fans is seriously deficient relative to the vicinity of perennial rivers. With the development of major urban areas and hazardous, radioactive, and mixed waste sites on alluvial fans in the southwestern United States, there is both an increasing need and interest in developing rational and reliable techniques for assessing the hazards floods pose to these developments and facilities. The three primary assumptions on which the assessment of flood hazard on alluvial fans are usually based were examined. Of these three assumptions, two were demonstrated to be reasonable based on a survey of the pertinent geologic and engineering literature and available field data while the third assumption which quantifies alluvial channel geometry during extreme flow events was shown to be invalid. A number of methods which may be used to predict alluvial channel geometry are discussed along with critical research needs. (See also W90-02507) (Author's abstract)
W90-02534

FLOOD DAMAGE-FREQUENCY ANALYSIS OF AN URBANIZING WATERSHED.
Louisville Univ., KY. Dept. of Civil Engineering.
N. R. Bhaskar.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 377-394, 5 fig, 5 tab, 18 ref.

Descriptors: *Flood damage, *Frequency analysis, *Urban watersheds, *Urban hydrology, *Flood frequency, *Urbanization, Floods, Hydrographs, Rainfall, Flood control, Hydrology, Land use, Runoff, Flood plains, Kentucky.

Urbanization resulted in serious flooding problems in the Beargrass Creek basin, which lies principally in the city of Louisville, Kentucky. The watershed is 60.9 sq m in size with the South Fork and Middle Fork as the two principal streams draining into the Ohio River. In order to mitigate the damage due to flooding, the U.S. Army Corps of Engineers, Louisville District undertook a study in 1973 to evaluate the existing and future flood damage potential in the watershed. Using the Clarks Instantaneous Unit Hydrograph approach and the rainfall events associated with the maximum annual flood events over the period of record (1941-1973), a flood-frequency analysis was carried out for both the present (1973) and future conditions (1990). Future flood conditions were simulated using projected Unit Hydrograph parameters and the historical rainfall record. The year 1990 was selected since the watershed is expected to be completely urbanized by that time. Backwater profiles were developed using the Army Corps of Engineers HEC-2 program to establish flood elevation-frequency curves in selected reaches. Using this information, flood damage-frequency curves, both under existing and projected conditions, were derived. In order to provide flood protection in the Beargrass Creek basin, several structural and nonstructural measures of flood control were examined. A dry-bed reservoir located upstream on the South Fork, was recommended as the best alternative using a combination of economic, environmental, technical and social criteria. A comparison of the flood damage-frequency curves under modified conditions along the South Fork due to the recommended dry-bed reservoir with similar curves under pre-development conditions is presented. The effect of the reservoir under existing and future conditions is to reduce flood damages. The reservoir is more effective in reducing damages in the upstream reaches of the South Fork. (See also W90-02507) (Stoehr-PTT)
W90-02535

FLOOD RISK BIAS ANALYSED THROUGH A MULTI-STATE FLOOD INSURANCE MODEL.
Victoria Dept. of Water Resources, Armadale (Australia).
For primary bibliographic entry see Field 7C.
W90-02536

CORPS OF ENGINEERS PROCEDURES FOR EVALUATING AND MODIFYING EXISTING DAMS TO SAFELY ACCOMMODATE THE CURRENT INFLOW DESIGN FLOOD.
Corps of Engineers, Washington, DC. Hydraulics and Hydrology Branch.
For primary bibliographic entry see Field 8A.
W90-02537

TVA PRACTICE IN FLOOD FREQUENCY AND RISK ANALYSIS.
Tennessee Valley Authority, Knoxville. Flood Protection Branch.
D. W. Newton.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 429-438, 24 ref.

Descriptors: *Tennessee Valley Authority, *Dams, *Flood frequency, *Historic floods, *Risk assessment, *Dam stability, *Frequency analysis, Data collections, Flooding, Nuclear powerplants, Flood plain management, Design criteria, Hydraulic structures, Maximum probable floods, Hydrologic data, Flood hazard.

In carrying out its responsibilities TVA has constructed dams and fossil and nuclear power plants, operates and maintains its dams including their safety evaluation, and maintains a program of floodplain management activities with communities, industries, and individuals. The flood frequency and risk analysis procedures used by TVA in these activities are described. Discussed are (1) TVA's conclusions about the most accurate methods to compute flood frequency at ungaged locations including use of limited site historic flood data obtained through TVA's flood documenting activities; (2) the procedures and data used by TVA to estimate the probable maximum flood (PMF) to ensure that estimates are realistic and compatible with meteorological experience; (3) approaches TVA has used to define flood frequencies of extreme events up to and including the PMF; and (4) risk analysis as applied by TVA in community planning and dam safety evaluations. Recommendations as to additional procedures needed to enhance the engineer's capability for improved flood frequency and risk analysis include: (1) a nationally consistent standard for determining the PMF; (2) an 'agreed-to' procedure to evaluate flood probabilities up to and including the PMF; (3) procedures for incorporating into the design decision the economic, social, and environmental impacts of dam failure; and (4) improved procedures for estimating flood frequencies at ungaged locations. (See also W90-02507) (Stoehr-PTT)
W90-02539

NUCLEAR REGULATORY COMMISSION USE OF FLOOD RISK ANALYSES.
Nuclear Regulatory Commission, Washington, DC.
R. G. Wescott.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 439-441.

Descriptors: *Risk assessment, *Flood frequency, *Floods, *Nuclear powerplants, *Flooding, *Regulations, *Nuclear Regulatory Commission, Flood hazard, Flood control, Coasts, Maximum probable floods, Rivers.

The Nuclear Regulatory Commission has recognized the potential hazards resulting from the flooding of a commercial nuclear power plant and has developed guidance for use in determining flood protection requirements for all plant sites and for reviewing flood protection aspects of proposed sites. In 1977, the Systematic Evaluation Program was initiated and showed that some of the older plants could not safely withstand the Design Basis Flood, as determined using current criteria. In these cases the feasibility of using engineered measures to meet current flood criteria is examined as the preferred alternative. In cases where this is judged not feasible, probabilistic evaluations of flooding potential are undertaken with caution. This approach is guided by two major principles: (1) to use as many independent procedures and/or data as possible to develop an understanding of the likely probability distribution of extreme flooding at the site; and (2) to use the data collected to establish an upper limit of probability associated with inundation. The NRC has not established any standardized procedures for flood risk analyses. The primary goal has been to quantify conservatively the risk associated with feasible alternatives for decreasing the flood vulnerability of such plants. (See also W90-02507) (Stoehr-PTT)
W90-02540

FLOOD RISK ANALYSIS FOR THE NATIONAL FLOOD INSURANCE PROGRAM.
Federal Insurance Administration, Washington, DC.
B. R. Mrazik.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Sym-

posium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 443-453, 9 ref.

Descriptors: *Risk assessment, *Flood hazard, *Flood insurance, *Flood frequency, *Frequency analysis, *Flood plain management, *Insurance, *Regulations, *Legislation, Land development, Flood damage, Flooding, Statistical analysis, Flood control, Flood basins, Coastal plains, National Flood Insurance Program.

Flood frequency and risk analysis play a fundamental role in the insurance, floodplain management and hazard mapping aspects of the National Flood Insurance Program. The analytic procedures commonly utilized in flood insurance studies of riverine floodplains include flood frequency analysis for gaged and ungaged streams and stage-frequency determinations. Coastal floodplain insurance studies include synthetic storm surge modeling, statistical analyses, and wave analyses. Consistency in flood frequency estimates over both time and space is needed to effectively administer the Program at national and local levels. Enhanced capability in risk analysis for flood-related hazards such as ice jams, erosion, levee failure, shifting channels, long term lake level fluctuations, and mudflows is also needed to support Program operations in these specialized hazard environments. (See also W90-02507) (Stoehr-PTT)
W90-02541

NATIONAL WEATHER SERVICE ROLE IN FLOOD FREQUENCY AND RISK ANALYSIS.
National Weather Service, Silver Spring, MD. Water Management Information Div.
E. M. Hansen.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 455-461, 2 tab, 6 ref.

Descriptors: *Risk assessment, *Flood hazard, *Meteorology, *Flood frequency, *Frequency analysis, *Probable maximum precipitation, Precipitation, Hydrology.

The National Weather Service (NWS) does not have a direct role in studies concerning flood-flow frequency and risk analysis; however, it does take part in a number of areas that are of interest to such studies. NWS publications are the primary source of probable maximum precipitation estimates and precipitation frequency studies in the United States. In the Western United States, Technical Paper No. 40 provided only a broad representation of the estimated distribution of frequencies. In 1973, a reanalysis of western data was completed and published in 11 volumes for the 11 Western United States. These superseded Technical Paper 40 for that region. In the east, another study superseded Technical paper No. 40 for precipitation frequencies $<$ 1 hr. Technical Paper No. 40 is still generally valid over the eastern U.S. for durations $>$ 1 hr. Most recently the NWS has been involved in an evaluation study to determine the 1000-yr precipitation-frequency estimates for selected sites in the Eastern U.S. The NWS is represented on two work groups organized to establish the state-of-the-art regarding the feasibility of assigning a probability to the probable maximum flood and to determining which are the most promising approaches for research in determining the probability of rare floods. (See also W90-02507) (Stoehr-PTT)
W90-02542

ROLE OF FLOOD-FREQUENCY ANALYSIS IN THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Reston, VA. Water Resources Div.
W. O. Thomas.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 463-484, 4 tab, 13 ref.

Descriptors: *Flood frequency, *Frequency analysis, *Water resources development, Hydrology, Data collections, Discharge measurement, Documentation, Flood plain management.

The U.S. Geological Survey (USGS) is involved in several flood-related activities as part of its mission to monitor the Nation's water resources. Techniques and approaches utilized in (1) archiving flood data, (2) analyzing flood data at gaging stations, (3) documenting extreme floods, (4) estimating flood-peak discharges at ungaged sites, (5) estimating flood-peak depths at ungaged sites, and (6) developing flood-hazards maps are described. A brief description of the future direction of flood-frequency analysis within the USGS includes the recommendation of using the generalized least squares technique to estimate the parameters of the multiple-regression equations in estimating flood discharge for ungaged sites. The USGS is also advocating an analysis of the regional hydrology network as a second step in the regionalization of flood-flow characteristics. (See also W90-02507) (Stoehr-PTT)
W90-02543

SOME REMARKS ON PRACTICE OF FLOOD FREQUENCY AND RISK ANALYSIS BY THE FEDERAL ENERGY REGULATORY COMMISSION.
Federal Energy Regulatory Commission, Washington, DC.
C. L. Cooper.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 485-489.

Descriptors: *Floods, *Flood frequency, *Frequency analysis, *Regulations, *Risk assessment, *Flood hazard, *Dam stability, *Dams, Safety, Design floods, Hydrographs, Statistical analysis, Flood flow, Design criteria.

The Federal Energy Regulatory Commission (FERC) has been in dam safety regulation since 1920. As of October 1, 1985, there were about 2,050 dams under its jurisdiction. Almost all of its spillway inflow design floods creep higher and higher with passing years. Mathematical probability methods provide no guidance to the shape and magnitude of the hydrographs of rare floods which would be substantially above the measured data. Risk analysis should include the probability of engineering, administrative, or other human error. Therefore, the FERC requires that the adequacy of both new and existing dams be evaluated by considering the hazard potential which would result from failure of the project works during flood flows. If structural failure would present a hazard to human life or cause significant property damage, the dam must withstand the loading or overtopping which may occur from a flood up to the probable maximum (risk analysis that involves loss of life is not permitted). In most cases, the dam owner is permitted to use risk analysis, if the failure will not cause loss of life or significant property damage. (See also W90-02507) (Author's abstract)
W90-02544

2F. Groundwater

INTRODUCTION TO THE HYDROGEOCHEMICAL INVESTIGATIONS WITHIN THE INTERNATIONAL STRIPA PROJECT.
Geological Survey, Menlo Park, CA.
D. K. Nordstrom, T. Olsson, L. Carlsson, and P. Fritz.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1717-1726, Aug 1989. 10 fig, 8 tab, 23 ref.

Descriptors: *Geochemistry, *Geohydrology, *Sweden, *Radioactive waste disposal, *Radioactive springs, *Radioactivity, Permeability, Radiochemistry, Mine drainage, Groundwater.

The International Stripa Project (1980-1990) has sponsored hydrogeochemical investigations at several subsurface drillholes in the granitic portion of an abandoned iron ore mine in central Sweden. The purpose has been to advance the understanding of geochemical processes in crystalline bedrock that may affect the safety assessment of high-level radioactive waste repositories. More than a dozen investigators have collected close to a thousand water and gas samples for chemical and isotopic analyses to develop concepts for the behavior of solutes in a granitic repository environment. The Stripa granite is highly radioactive and has provided an exceptional opportunity to study the behavior of natural radionuclides, especially subsurface production. Extensive microfracturing, low permeability with isolated fracture zones of high permeability, unusual water chemistry, and a typical granitic mineral assemblage with thin veins and fracture coatings of calcite, chlorite, sericite, epidote and quartz characterize the site. Preliminary groundwater flow modeling indicates that the mine has perturbed the flow environment to a depth of about 3 km and may have induced deep groundwaters to flow into the mine. (Author's abstract)
W90-01967

GROUNDWATER CHEMISTRY AND WATER-ROCK INTERACTIONS AT STRIPA.
Geological Survey, Menlo Park, CA.
D. K. Nordstrom, J. W. Ball, R. J. Donahoe, and D. Whittemore.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1727-1740, Aug 1989. 14 fig, 2 tab, 55 ref.

Descriptors: *Geochemistry, *Sweden, *Boreholes, *Trace elements, Granites, Calcium carbonate, Sodium, Chlorides, Total dissolved solids, Conductivity, Thermomechanical stress, Precipitation, Solubility, Salinity, Groundwater chemistry.

Groundwaters from near surface to a depth of 1232 m in the Stripa granite have been sampled and analyzed for major and trace constituents. The groundwater composition consists of two general types: a typical recharge water of Ca-HCO_3 type ($<$300 m depth) and a deeper Na-Ca-Cl type ($<$700 m depth) of high pH (8-10) that reaches a maximum of 1250 mg/L in total dissolved solids (TDS). Intermediate depths show mixtures of the two types that are highly fracture dependent rather than depth-dependent. Any borehole can vary significantly and erratically in TDS for either a horizontal or vertical direction. The general transition from Ca-HCO_3 type to Na-Ca-Cl type correlates with the depth profile for hydraulic conductivity that drops from 10 to the minus 8th power m/s to 10 to the minus 11th power m/s or lower. Thermomechanical stress (from heater experiments) clearly shows an effect on the groundwater composition that could be caused by changing flow paths, leakage of fluid inclusions or both. Dissolution and precipitation of calcite, fluorite and barite, aluminosilicate hydrolysis, and addition of a saline source (possibly fluid inclusion leakage) play the major roles in defining the groundwater composition. The low permeability of the Stripa granite has produced a groundwater composition that appears intermediate between the dilute, shallow groundwaters typical of recharge in a crystalline rock terrain and the saline waters and brines typical of cratonic shield area at depth. (Author's abstract)
W90-01968

FLUID INCLUSIONS IN THE STRIPA GRANITE AND THEIR POSSIBLE INFLUENCE ON THE GROUNDWATER CHEMISTRY.
Geological Survey, Menlo Park, CA.
D. K. Nordstrom, S. Lindblom, R. J. Donahoe, and C. C. Barton.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1741-1755, Aug 1989. 12 fig, 3 tab, 55 ref.

Descriptors: *Water chemistry, *Geochemistry, *Sweden, *Geologic fractures, *Geologic history, *Fracture permeability, Stripa granite, Salinity, Porosity, Density, Groundwater chemistry.

Fluid inclusions in quartz and calcite of the Proterozoic Stripa granite, central Sweden, demonstrate that the rock and its fracture fillings have a complex evolutionary history. The majority of inclusions indicate formation during a hydrothermal stage following emplacement of the Stripa pluton. Total salinities of quartz inclusions range from 0-18 eq.wt% NaCl for unfractured rock and from 0-10 eq.wt% for fractured rock. Vein calcites contain up to 25 eq.wt% NaCl but the inclusion size is larger and the population density is lower. Homogenization temperatures are 100-150 degrees C for unfractured rock and 100-250 degrees for fractured rock. Pressure corrections, assuming immediate post-emplacement conditions of 2 kbar, give temperatures about 160 C degrees higher. Measurements of fluid-inclusion population-densities in quartz range from about 10 to the 8th power inclusions/cu cm in grain quartz to 10 to the 9th power inclusions/cu cm in vein quartz. Residual porosity from inclusion densities has been estimated to be at least 1% which is two orders of magnitude greater than the flow porosity. Breakage and leaching of fluid inclusions is proposed as an hypothesis for the origin of major solutes (Na-Ca-Cl) in the groundwater. Evidence for the hypothesis is based on: (1) mass balance--only a small fraction of the inclusions need to leak to account for salt concentrations in the groundwater; (2) chemical signatures--Br/Cl ratios of fluid inclusion leachates (0.0101) match those ratios for the deep groundwaters (0.0107); (3) leakage mechanisms--microstresses from isostatic rebound or mining activities acting on irregular-shaped inclusions could cause breakage and provide connection with the flow porosity; and (4) experimental studied--water forced through low permeability granites leach significant quantities of salt. This hypothesis is consistent with the available data although alternate hypotheses cannot be excluded. (Author's abstract)
W90-01969

DEUTERIUM, OXYGEN-18, AND TRITIUM IN STRIPA GROUNDWATER.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie.
H. Moser, M. Wolf, P. Fritz, J. Fontes, and T. Florkowski.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1757-1763, Aug 1989. 5 fig, 2 tab, 30 ref.

Descriptors: *Sweden, *Deuterium, *Oxygen isotopes, *Geochemistry, *Water chemistry, *Tritium, *Isotope studies, Stripa granite, Salinity, Boreholes, Groundwater recharge, Geologic fractures, Aging, Groundwater chemistry.

Deuterium, Oxygen-18 and tritium determinations show that groundwaters in the fractures of the Stripa granite are of meteoric origin, not affected by secondary isotope effects (evaporation or isotope exchange). Deep groundwaters have lower O18 and H2 contents than recent, shallow groundwaters. The differences are most likely due to recharge during cooler climatic conditions. However, no age information can be derived because recharge could have occurred before the last major climatic improvement following the last deglaciation, during minor climatic variations during the more recent past, or could be the result of regional groundwater flow. Low O18 contents are paralleled by increasing salinities with highest salinities limited to a narrow fracture zone at a depth of about 800 m below ground surface. Most saline waters sampled appear to represent mixtures of a saline component with an isotopically depleted water and local fresh water. The presence of young groundwaters is indicated by bomb produced H3. All surface boreholes contain tritium, indicating residence times <35 years. However, tritium is also found in some boreholes drilled at the 300 m mine levels and its presence may be due to flows induced in response to heater tests. Low but detectable H3 contents (about 0.1 to 1 TU) in V2 at about 850 m below groundsurface are attributed to either subsurface production and/or a result of admixtures of small amounts of recent water to old groundwater. (Author's abstract)
W90-01970

ISOTOPE GEOCHEMISTRY OF CARBON IN GROUNDWATER AT STRIPA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
P. Fritz, J. Fontes, S. K. Frape, D. Louvat, and J. Michelot.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1765-1775, Aug 1989. 7 fig, 2 tab, 32 ref.

Descriptors: *Water chemistry, *Geochemistry, *Sweden, *Isotope studies, *Carbon radioisotopes, *Geochemistry, Hydrogen ion concentration, Inorganic carbon, Organic carbon, Water depth, Geologic fractures, Stripa granite, Pluton, Flow pattern, Groundwater chemistry.

The carbon isotopic composition of the total dissolved inorganic carbon in groundwater associated with a granitic pluton at Stripa (Sweden) reflects both inorganic and organic carbon sources. Following the uptake of soil carbon-dioxide, calcite dissolution dominates the geochemical evolution of shallow groundwater. Calcite saturation is reached at a depth of about 100 m. In deeper waters geochemical release of Ca and increasing pH cause calcite precipitation. Radiocarbon contents suggest carbon (and possibly water) ages in excess of 20,000 years for waters at 300-400 m depths. In deep groundwaters with enhanced salinities organic carbon is added to the dissolved inorganic carbon either through bacterial activity (e.g. sulfate reducing bacteria) or the oxidation of organic compounds such as methane. The lowest radiocarbon contents were measured at the 300-400 meter levels and not in the deepest fluids. The distribution of C13 in the deep groundwaters suggests the existence of well-defined flowsystems with limited active hydraulic interaction. Isotope analyses on fracture calcites substantiate the complex geochemical history of the pluton. (Author's abstract)
W90-01971

AQUEOUS SULPHATES FROM THE STRIPA GROUNDWATER SYSTEM.
Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique.
J. Fontes, P. Fritz, D. Louvat, and J. Michelot.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1783-1789, Aug 1989. 5 fig, 3 tab, 36 ref.

Descriptors: *Water chemistry, *Geochemistry, *Sweden, *Sulfates, *Sulfur, Stripa pluton, Fallout, Pyrite, Groundwater chemistry, Water depth, Saline water, Geochemistry, Sulfate reduction.

The isotopic composition of aqueous sulfate in the groundwater in the Stripa pluton reflects the geochemical history of the groundwater as well as the origin of the sulfur or sulfate. In shallow, modern groundwater, sulfate originates from fallout and the oxidation of pyrite or other reduced forms of sulfur. At intermediate depths, sulfate of surface origin is lost through bacterial reduction. The origin of sulfate in the deep and more saline water is not clearly defined but could be derived from a sedimentary brine which was subject to substantial modification through rock-water interaction. Bacterial sulfate reduction also occurs locally at depths below about 800 m. (Author's abstract)
W90-01972

NATURAL RADIOELEMENT SOLUTION BY CIRCULATING GROUNDWATERS IN THE STRIPA GRANITE.
Bath Univ. (England). School of Chemistry.
J. N. Andrews, D. J. Ford, N. Hussain, D. Trivedi, and M. J. Youngman.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1791-1802, Aug 1989. 2 fig, 5 tab, 38 ref, append.

Descriptors: *Geochemistry, *Water chemistry, *Sweden, *Radioactive springs, *Radiochemical analysis, *Radioisotopes, Uranium radioisotopes, Polonium, Radon, Thorium, Radium, Stripa granite, Water depth, Geologic fractures, Groundwater, Leaching, Coal mining.

Natural radioelement concentrations in groundwaters from the fracture flow regime in the Stripa granite were monitored during the period 1977-1986. Uranium concentrations from depths of 80 m or less and in minewaters from above the hydraulic sink produced by the deepest mining level (410 m), range from 10 to 90 ppb. U234/U238 activity ratios are characteristic of chemical leaching processes at the shallower depths while at about 350 m groundwaters occur which have an additional component of U234. At greater depths, U concentrations are indicative of the changed redox conditions and are subject to activity ratio enhancement by the alpha-recoil process. Groundwater residence times may be estimated from the rate of such recoil solution of U234 in zones where chemical leaching of U is not active. The Rn222 contents of the minewaters are extremely high and can be related to the Rn222 flux from fracture surfaces and the fracture width. The fracture apertures range from 10 mm for the shallow groundwater zone (Rn222 contents <400 Bq/kg) to 20 microm for water from the deepest borehole section (Rn222 content 100 kBq/kg). The activity ratios Th234/U238, Pb210/Rn222 and Po210/Rn222 have been used to estimate residence times for Th, Pb and Po isotopes. Solution of Ra is controlled by chemical rather than alpha-recoil processes. The Ra226 content of the groundwater increases with salinity and is well correlated with groundwater Ca content. The Ra228/Ra226 activity ratios in the groundwaters suggest that water/rock interaction occurs predominantly with the average granitic matrix rather than with highly uraniferous fracture mineralization. The behavior of Ra, Th and Po isotopes may be used to assess that of homologous fission product and actinide constituents of nuclear wastes in groundwaters. (Author's abstract)
W90-01973

IN SITU PRODUCTION AND MIGRATION OF I129 IN THE STRIPA GRANITE, SWEDEN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
J. T. Fabryka-Martin, S. N. Davis, D. Elmore, and P. W. Kubik.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 8, p 1817-1823, Aug 1989. 2 fig, 3 tab, 33 ref. U.S. Department of Energy Contract W-31-109-ENG-38.

Descriptors: *Sweden, *Water chemistry, *Geochemistry, *Iodine radioisotopes, *Radioisotopes, Groundwater chemistry, Stripa granite, Geologic fractures, Diffusion, Accelerator mass spectrometry.

Concentrations of natural I129 and Cl36 in groundwater from the Stripa granite, Sweden, were determined by accelerator mass spectrometry. The I129 values range from 1 x 10 to the 6th power to 2 x 10 to the 8th power atoms/L, orders of magnitude greater than the estimated background concentration in pre 1945 rainwater of 2 x 10 to the 4th power atoms/L. Expressed as a ratio I129/I172, values range from 3 x 10 to the minus 12th power to 2 x 10 to the minus 10th power, compared to about 1 x 10 to the minus 12th power in pre 1945 rainwater. Ratios, as well as concentrations generally increase with sample depth, which ranges from 360 m to >1000 m below the surface. The accumulation of I129 in the water is attributed to subsurface production by spontaneous fission of U238 in micro-fractures in the granite matrix and subsequent transfer of this I129 by diffusion into fractures constituting the flow system of the granite. Uncertainties in the spontaneous-fission yield at mass 129 and in the assumption of steady-state mass flux prevent quantitative estimates of the rate of I129 transfer. (Author's abstract)
W90-01974

ARGON-39, ARGON-37 AND KRYPTON-85 ISOTOPES IN STRIPA GROUNDWATERS.
Bern Univ. (Switzerland). Physikalisches Inst.
H. H. Loosli, B. E. Lehmann, and W. Balderer.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 8, p 1825-1829, Aug 1989. 1 fig, 6 tab, 12 ref.

Descriptors: *Water chemistry, *Geochemistry, *Sweden, *Switzerland, *Radioisotopes, Ground-

water chemistry, Argon, Krypton, Uranium, Stripa granite, Groundwater fractures, Comparison studies.

Ar39, Ar37 and Kr85 activities in groundwater samples from three boreholes in the Stripa granite were compared with Rn222 activities and with data from a granitic groundwater in Switzerland. In situ production rates in bulk granite and in fracture filling minerals were calculated. The measured isotopes in groundwater have been produced by nuclear reactions in the rock matrix. It was reported earlier that a large fraction of the in situ produced Rn222 can escape to the water phase due to the unusual microscopic distribution of U which seems to be in close contact with the water phase. The same conclusion can be drawn for Kr85 with escape factors between 5% and 25%. The Ar39 values in Stripa groundwaters are the highest measured so far but consistent with the unusually high neutron-flux in Stripa as compared to granites with lower U-contents and Th-contents. The Ar37 concentrations appear to be quite high, but since it is the first time that this isotope has been identified in groundwater the basis for a comparison with different rock formations is still too small. It seems possible that calcite fracture fillings in Stripa have a major influence on the concentration of Ar37 in groundwater. (Author's abstract)
W90-01975

ATMOSPHERIC AND RADIOGENIC GASES IN GROUNDWATERS FROM THE STRIPA GRANITE.
Bath Univ. (England). School of Chemistry.
J. N. Andrews, N. Hussain, and M. J. Youngman.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1831-1841, Aug 1989. 4 fig, 4 tab, 37 ref, append.

Descriptors: *Water chemistry, *Geochemistry, *Sweden, *Radioactive dating, Radioisotopes, *Helium, Diffusion, Groundwater chemistry, Geochemistry, Uranium, Advection, Groundwater fractures, Stripa granite, Argon, Gases.

Groundwaters from depths of 350 m to 1250 m in the Stripa granite contain dissolved radiogenic He in amounts up to 50,000 times that due to air-saturation. The groundwater He-contents increase with depth and lie close to the expected profile for He loss by aqueous diffusion (D = 0.032 sq m/a). Measurements on core samples show that the rock has retained about 10% of the possible cumulative radiogenic He and that this component is lost by matrix diffusion (D = 5 x 10 to the minus 7th power/sq m/a). Diffusive equilibrium between He in fracture fluids and in the adjacent rock matrix can be rapidly established for the narrow fracture widths of the flow system. A major loss of stored He by both diffusion and advection along fluid-filled fractures is attributed to the proximity of a major fraction of uranium to the aqueous flow system because of its deposition within an interconnective microfracture system. The crustal flux of He is limited by its diffusion coefficient in the matrix of a granitic crust but may be supplemented by transport due to fluid circulation. The He3/He4 ratio of the excess He present in the Stripa groundwaters, corresponds to that expected for radiogenic He production within the granite. The Ar40/Ar36 ratio of dissolved Ar shows that radiogenic Ar40 has been released from the rock matrix, especially for groundwaters from greater than 450 m depth. Slow alteration reactions are the most probable cause of this radiogenic Ar40 release which has occurred in the more saline groundwaters. Groundwater recharge temperatures, estimated from their noble gas contents, are about 3 degrees C lower than those for modern shallow groundwaters in the locality and are related to the stable isotope composition of the groundwater. Most groundwater age measures at Stripa are the result of mixing between recent recharge waters (<100 a) and a much older fracture-stored brine. (Author's abstract)
W90-01976

CONJUNCTIVE USE OF GEOPHYSICAL AND GEOLOGICAL DATA IN THE STUDY OF AN ALLUVIAL AQUIFER.
Nebraska Univ., Lincoln. Conservation and Survey Div.
For primary bibliographic entry see Field 7B.
W90-02019

CORRELATIONS OF PERMEABILITY AND GRAIN SIZE.
Soil Conservation Service, Des Moines, IA.
R. G. Shepherd.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 633-638, 3 fig, 1 tab, 45 ref.

Descriptors: *Permeability, *Particle size, *Unconsolidated sediments, Regression analysis, Mathematical equations, Maturity criteria, Dunes, Beaches, River sediments.

Previous theoretical and empirical investigations of the relation between particle size and intergranular permeability have resulted in the well-known formula for intrinsic permeability (k) k = cd to the second power where d is particle diameter, and c is a dimensionless constant. Statistical power regression analyses were performed on 19 sets of published data on size and laboratory permeability of unconsolidated sediments. The exponent of grain diameter ranged from 1.11 to 2.05, but most values were significantly less than 2.0. Results indicate that the permeability/grain size relation alternatively may be expressed, from an empirical basis, as k = cd to the 1.65 to 1.85 power. Values of c and the exponent both generally decrease with the decreased textural maturity and increased induration. From the data acquired a generalized graphical functional relation of grain size and permeability was prepared and the permeability of a texturally mature sediment was estimated using regression equations with slopes higher than 1.75, and that of a texturally immature sediment using regression lines with lower slopes. Using maturity criteria and data from the literature, fields of permeability for grain sizes of dune, beach, and river sediments were indicated. (Author's abstract)
W90-02020

PHYSICAL CONTROL ON HYDROCHEMICAL VARIABILITY IN THE INNER BLUEGRASS KARST REGION OF CENTRAL KENTUCKY.
Texas Univ. at Austin. Bureau of Economic Geology.
B. R. Scanlon.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 639-646, 5 fig, 1 tab, 24 ref.

Descriptors: *Karst, *Geochemistry, *Water chemistry, *Kentucky, *Springs, *Wells, Calcium, Magnesium, Carbonates, Groundwater chemistry, Sodium chloride, Seasonal variation, Hydraulic conductivity, Dissolved solids.

Areal and temporal variations in physical and chemical characteristics of groundwater in the Inner Bluegrass Karst Region of central Kentucky were used to evaluate physical controls on hydrochemical variability. The karst region consists of flat-lying interbedded limestones and shales. Physical attributes of the aquifer were assessed on the basis of spring discharges, static water levels in wells and pumping tests. Areal and temporal variation in groundwater chemistry were determined from major-ion analysis of water samples from 15 springs and 24 wells over a 17-month period. Water samples were divided into three chemical types on the basis of the relative concentrations of the dominate ions: Ca-Mg-HCO3, Na-HCO3, and NaCl water. Ca-Mg-HCO3 water was divided further on the basis of Ca/Mg molar ratios into Ca subtype water (Ca/Mg > 6) and Ca-Mg subtype water (Ca/Mg < 6). Pumping tests show that hydraulic conductivities in zones of Ca-Mg-HCO3 water are significantly higher than those in zones of Na-HCO3 and Na-Cl water. There is no regional trend in the distribution of these water types. Temporal fluctuations in water chemistry correlate with seasonal fluctuations in recharge. Large scale seasonal variations in ionic concentrations occur primarily in Ca subtype water. Hydraulic conductivities, seasonal variations in ionic concentrations, and TDS suggest that groundwater residence time is the primary control on the occurrence of the different water types. Differences in residence time are attributed to the presence of discontinuous, horizontal shales that control the rate and depth of active groundwater circulation. (Author's abstract)
W90-02021

SHAPE FACTORS FOR PERMEABILITY TESTS IN BOREHOLES AND PIEZOMETERS.
Ecole Polytechnique, Montreal (Quebec). Dept. de Genie Mineral.
R. P. Chapuis.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 647-654, 7 fig, 1 tab, 42 ref.

Descriptors: *Well drilling, *Pumping tests, *Aquifer testing, *Boreholes, *Piezometers, *Permeability, Shape factors, Mathematical equations, Injection, Hydraulic conductivity.

Several sets of values are available for the shape factor of the cylindrical injection zone used to perform a field permeability test. Depending on the selected value, the resulting difference for hydraulic conductivity may reach 40% for long intake zones, and more than 100% for short intake zones. The commonly used shape factor is that given by Hvorslev. Seven other factors derived from numerical models are now available: they differ from Hvorslev's factor up to 100%. Three possible reasons for the differences are: (1) inaccuracies in numerical methods; (2) reference to a theoretical equation that is not always the right one; and (3) recharging (constant head) or impervious boundaries not representative of theoretical ones. Shape factor values obtained by numerical methods are shown to be more or less accurate solutions of particular cases when impervious or recharging boundaries exist close to the injection zone. Their influence upon the shape factor value can be calculated analytically. Analytical shape factor equations are given for a cylindrical injection zone with either a pervious or an impervious bottom. Based on the method of image wells, two other equations are established to correct the shape factors if draining (constant head) or impervious layers are known to be located close to the injection zone. These equations should be used for field permeability tests in boreholes or piezometers. (Author's abstract)
W90-02022

NUMERICAL IDENTIFICATION OF PARAMETERS IN LEAKY AQUIFERS.
National Chiao Tung Univ., Hsinchu (Taiwan). Dept. of Civil Engineering.
H. D. Yeh, and H. Y. Han.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 655-663, 6 fig, 3 tab, 25 ref.

Descriptors: *Groundwater movement, *Aquifers, *Leaky aquifers, *Pumping tests, Storage, Drawdown, Hantush formula, Jacob formula, Newton method, Graphical methods, Mathematical analysis.

A method using the nonlinear least-squares and finite difference Newton's method is presented to identify the parameters from pumping tests in homogeneous and isotropic leaky aquifers both for situations with and without storage effects in the aquitard. Based on the least-squares approach, the sum of the differences between the observed drawdowns and predicted drawdowns using the estimated parameters is minimized. The finite-difference Newtown's method is used to solve the system of nonlinear least-squares equations for the unknown aquifer parameters. Comparisons of the results among the proposed method, graphical method, and sensitivity analysis method when analyzing various data indicate that the parameters estimated by the proposed method using the Hantush and Jacob formula produce the least prediction error and best fit for Sridharan's pumping data. The proposed method has the merit of good accuracy and quick convergence from some initial guesses. (Author's abstract)
W90-02023

DISSIMILATORY NITRATE REDUCTION IN A WASTE-WATER CONTAMINATED AQUIFER.
STS Consultants Ltd., Minneapolis, MN.
For primary bibliographic entry see Field 5B.
W90-02024

MODELING TRANSPORT OF A DEGRADABLE CHEMICAL AND ITS METABOLITES IN THE UNSATURATED ZONE.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
U. S. Tim, and S. Mostaghimi.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 672-689, 3 fig, 1 tab, 34 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Unsaturated zone, *Pesticides, *Biodegradation, *Soil water, *Soil contamination, Mathematical models, Pesticides, Convective transport, Hydrodynamic dispersion, Ionic exchange, Biological degradation, Hydrolysis, Isotherms, Aldicarb, Aldicarb sulfoxide.

A mathematical model for transport and transformation of a pesticide and its metabolites in the soil is presented. Mechanisms for convective-transport, hydrodynamic dispersion, ionic exchange, biological degradation, and hydrolysis are accounted for in the mathematical formulation. The major assumptions used in developing the model include: flow in the soil is in the vertical direction and one-dimensional; soil system is homogeneous and isotropic; volumetric water content and Darcy's flux are constant in time and space; and a linear reversible Freundlich isotherm describes the concentrations in the aqueous and adsorbed phases. The applicability and potential of the model are demonstrated by predicting the transport and transformation of aldicarb (a nematicide of agricultural significance) and its metabolite, aldicarb sulfoxide, in the soil. This model may prove useful for: (1) predicting the movement of various chemicals such as fungicides, nitrogen fertilizers, and radionuclides in the soil for a better understanding and estimation of different mechanisms affecting their transport; (2) determining transport parameters such as dispersion coefficients from measured laboratory or field data and offer a most useful means for an initial estimation of order of magnitude of the extent of groundwater contamination by organic compounds; and (3) verifying the accuracy of numerical models used for predicting chemical transport in the subsurface. (Author's abstract)
W90-02025

USE OF GEOPHYSICAL LOGS TO ESTIMATE WATER QUALITY OF BASAL PENNSYLVANIAN SANDSTONES, SOUTHWESTERN ILLINOIS.
Illinois State Geological Survey Div., Champaign.
V. L. Poole, K. Cartwright, and D. Leap.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 682-688, 10 fig, 14 ref.

Descriptors: *Borehole geophysics, *Electrical well logging, *Illinois, *Aquifers, *Groundwater quality, *Groundwater reservoirs, Dissolved solids, Sandstone aquifers, Hydrologic data, Porosity, Permeability, Potable water, Pennsylvanian sandstone, Calcium, Magnesium, Bicarbonates, Sulfates, Chlorides, Sodium.

Freshwater is found at depths up to 1,000 ft in basal Pennsylvanian sandstone aquifers along the southern margin of the Illinois Basin. These aquifers, though not highly productive, represent a significant potential source of groundwater in a region of very limited groundwater supplies. A pilot study was undertaken in southwestern Illinois using geophysical logs and limited hydrologic data to evaluate the potential of these aquifers. Water quality, porosity, and permeability were estimated from the geophysical logs; these data were then used in conjunction with data from aquifer performance tests to delineate a zone of potable water. The data indicate the total dissolved solids increase to the northeast away from the outcrop area of the Pennsylvanian sandstones, and fresher water tends to trend northeasterly along paleochannels cut into Mississippian deltaic rocks and filled with high-permeability Pennsylvanian sandstones. Water quality changes along these trends from predominantly calcium-magnesium-bicarbonate-sulfate water near the recharge areas to sodium-calcium-bicarbonate-chloride water to the northeast. The fresher water containing less than 1000ppm TDS sits as a wedge-shaped lens extending between formation water of poorer quality northeast from the outcrop area. Changes in water type and TDS concentration with distance from the outcrop area are an expression of water residence time within the aquifer. (Author's abstract)
W90-02026

GEOCHEMICAL COMPARISON OF GROUND WATER IN AREAS OF NEW ENGLAND, NEW YORK, AND PENNSYLVANIA.
Geological Survey, Albany, NY. Water Resources Div.
R. J. Rogers.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 690-712, 9 fig, 4 tab, 48 ref.

Descriptors: *Geochemistry, *New York, *Pennsylvania, *New England, *Groundwater reservoirs, *Aquifers, Feldspathic rock, Carbonate rocks, Terrigenous sedimentary rock, Carbon dioxide, Glacial drift, Minerals.

The groundwater geochemistry of glacial drift and bedrock of selected areas of New England, New York, and Pennsylvania differs considerably among the areas as a result of differences in bedrock geology. The New England study area is underlain primarily by feldspathic rock, large areas of New York are underlain primarily by carbonate and terrigenous sedimentary rock and some evaporite deposits, and glaciated areas of Pennsylvania are underlain primarily by clastic sedimentary rock with minor carbonate rocks. Mean concentrations of most solutes are greatest in the New York area and least in the New England area. In New England, the groundwater geochemistry with results mainly from the reaction of CO2-charged water with feldspar and other primary silicates. Water in the New England bedrock is more highly evolved geochemically than water in the drift, presumably as a result of its longer residence time. In the New York area, the geochemistry of water in both types of aquifers results mainly from carbonate-mineral dissolution. Water in most glacial drift and bedrock is saturated with respect to calcite. In some parts of New York, the dissolution of evaporite minerals has a marked effect on the water chemistry of the bedrock. In most of the Pennsylvania area, the geochemistry of water in both types of aquifers indicates that, although carbonate minerals are the principal reactants, their influence on water chemistry is less than in New York. In parts of Pennsylvania, chemical differences between groundwater from drift and groundwater from bedrock are attributed to a higher proportion of reactive minerals in the drift than in the local bedrock as a result of glacial transport. (Author's abstract)
W90-02027

SLUG TEST PACKER FOR FIVE-CENTIMETER (TWO-INCH) WELLS.
National Water Research Inst., Burlington (Ontario). Groundwater Contamination Section.
For primary bibliographic entry see Field 7B.
W90-02028

EFFECTS OF SITE VARIATIONS ON SUBSURFACE BIODEGRADATION POTENTIAL.
CH2M/Hill, Corvallis, OR.
For primary bibliographic entry see Field 5B.
W90-02106

GEOLOGY AND HYDROLOGY OF THE DEEP SUBSURFACE MICROBIOLOGY SAMPLING SITES AT THE SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Furman Univ., Greenville, SC. Dept. of Geology.
K. A. Sargent, and C. B. Fliermans.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 3-13, 1989. 2 fig, 12 ref. DOE Grants DE-AC09-76SR00001 and DE-FG05-ER60606.

Descriptors: *Geohydrology, *Water pollution treatment, *Microorganisms, *Aquifers, *Groundwater pollution, *Path of pollutants, *Geology, *Hydrology, History, Subsurface sampling, Boreholes, Biorestoration, South Carolina.

Groundwater resources in the United States are in great jeopardy due to human contamination. The presence of a significant microflora in the deep subsurface has enormous implications for in situ bioremediation or biotransformations of toxicants in contaminated aquifers and deep unstaturated sediments. In order to provide fundamental information on the geology and hydrology of the deep subsurface microbiological sampling sites at the Savannah River Plant (a 768 sq km restricted-access facility near Aiken, South Carolina), subsurface sediment samples were collected from boreholes being drilled at the plant, and the geological history of the area was reviewed. There are three hypotheses as to how the microorganisms became associated with the sediments at the Savannah River Plant: (1) the organisms could have been displaced during weathering and then carried to the groundwater table by surface water percolating downward; (2) the organisms may have been transported to their present locations by groundwater percolating into the aquifers from their recharge areas; or (3) microorganisms were introduced into the sediments during deposition and have a long history of isolation. The documentation of active bacterial communities at depth establishes the potential for in situ biorestoration of aquifers. The ability of these bacteria to grow on a variety of media and to utilize a wide range of carbon sources suggest the possibility that the organisms could be stimulated in situ and their degradative capacities enhanced for the complete biodegradation or detoxification of some hazardous wastes. (White-Reimer-PTT)
W90-02118

DISTRIBUTION OF AEROBIC BACTERIA, PROTOZOA, ALGAE, AND FUNGI IN DEEP SUBSURFACE SEDIMENTS.
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
J. L. Sinclair, and W. C. Ghiorse.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 15-31, 1989. 3 fig, 4 tab, 37 ref. DOE Grant DE-FG02-86ER6047.

Descriptors: *Sediment analysis, *Soil profiles, *Groundwater pollution, *Microorganisms, Algae, Protozoa, Bacteria, Fungi, South Carolina, Boreholes, Hydrogen ion concentration, Diversity, Clays, Sand, Metals.

The distribution of microorganisms in deep subsurface profiles was determined at three sites at the Savannah River Plant, Aiken, South Carolina. Acridine orange direct counts (AODC) of bacteria were highest in surface soil samples and declined to the 10 to the sixth power to 10 to the seventh power/gram range in the subsurface, but then did not decline further with depth. In the subsurface, AODC values varied from layer to layer, the highest being found in samples from sandy aquifer formations and the lowest in clayey interbed layers. Sandy aquifer sediments also contained the highest numbers of viable bacteria as determined by aerobic spread plate counts (CFU) on a dilute heterotrophic medium. In some of these samples bacterial CFU values approached 100% of the AODC values. Viable protozoa (amoebae and flagellates, but no ciliates) were found in samples with high bacteria CFU values. A variety of green algae, phytoflagellates, diatoms, and a few cyanobacteria were found at low population densities in samples from two of the three boreholes. Low numbers of fungi were evenly distributed throughout the profiles at all three sites. Microbial population density estimates correlated positively with sand content and pore-water pH, and negatively with clay content and pore-water metal concentration. A large diversity of prokaryotic and eukaryotic microorganisms was found in samples with high population densities. A survey of bacterial strains isolated from subsurface samples revealed associations of gram-positive bacteria with high clay sediments and gram-negative bacteria with sandy sediments. The ability to deposit lipophilic storage

material (presumably poly-b-hydroxybutyrate) was found in a high proportion of isolates from sandy sediments, but only rarely in isolates from high clay sediments. (Author's abstract)
W90-02119

NUMBERS, DIVERSITY, AND MORPHOLOGICAL CHARACTERISTICS OF AEROBIC, CHEMOHETEROTROPHIC BACTERIA IN DEEP SUBSURFACE SEDIMENTS FROM A SITE IN SOUTH CAROLINA.
Florida State Univ., Tallahassee. Dept. of Biological Science.
D. L. Balkwill.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 33-52, 1989. 2 fig, 5 tab, 36 ref. DOE Grants DE-FG05-86ER-60478 and DE-FG05-88ER-60685.

Descriptors: *Bacteria, *Sediment analysis, South Carolina, Aerobic bacteria, Chemoheterotrophic bacteria, Mesophilic bacteria, Psychrophilic bacteria, Thermophilic bacteria, Microflora, Diversity.

The aerobic, chemoheterotrophic bacteria indigenous to deep aquifer and other subsurface sediments (depths to 265 m) at a site in South Carolina were characterized by direct microscopy, enumeration of viable cells, analysis of colony morphologies on plates, and analysis of cell morphologies of isolated strains. Substantial numbers of viable bacteria (10 to the fifth power-ten to the eighth power/g) were present in all transmissive, aquifer sediments, and their numbers did not decrease with depth. Fewer bacteria (<10 to the third power/g) were detected in nontransmissive, confining layers. The highest viable counts were obtained on dilute media, but 10-50% of the bacteria in most aquifer sediments also grew rapidly on concentrated, nutrient-rich media (indicating a high degree of metabolic flexibility). Most of the bacteria were mesophilic; relatively few psychrophiles or thermophiles were detected (< 10 to the third power/g; in many cases, none). The bacterial flora was diverse (11-62 distinct colony types on enumeration plates of most aquifer sediments). Diversity did not decrease with depth, but the composition of the microflora (based on colony analysis) varied extensively from one geological formation to another. Almost 95% of the platable colonies that grew on enumeration plates contained nonstreptomycete bacteria, more than 80% of which were gram-negative rods. Light microscopy of films released from aquifer sediments by flotation revealed the presence of dividing cells and microcolonies, thus implying that the in situ deep aquifer microflora was more metabolically active than that seen previously in shallow aquifers. (Author's abstract)
W90-02120

LITHOTROPHIC AND HETEROTROPHIC BACTERIA IN DEEP SUBSURFACE SEDIMENTS AND THEIR RELATION TO SEDIMENT PROPERTIES.
Battelle Pacific Northwest Labs., Richland, WA.
J. K. Fredrickson, T. R. Garland, R. J. Hicks, J. M. Thomas, and S. W. Li.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 53-66, 1989. 7 fig, 2 tab, 39 ref. DOE Grant DE-AC06-7A6RLO 1830.

Descriptors: *Bacteria, *Microorganisms, *Sediment-water interfaces, Sediment analysis, Lithotrophic bacteria, Heterotrophic bacteria, Sediment texture, Porosity, Hydraulic conductivity, Nitrogen fixing bacteria, Sulfur-oxidizing bacteria.

Subsurface sediments obtained from cores drilled to depths of 260 m below the surface in South Carolina were analyzed for heterotrophic bacteria; N2-fixing microaerophiles; and nitrifying, sulfur-oxidizing, and H2-oxidizing lithotrophic bacteria. In addition, pore waters were extracted for chemical analysis of inorganic nitrogen species, sulfate, dissolved organic carbon, pH, and Eh. Autotrophic populations were generally less than 1000 most probable number (MPN)/g dry sediment with sulfur-oxidizing bacteria, detected in 60% of the sediment samples, being the most frequently encountered group. Nitrifying bacteria were detected mainly in sediments from one borehole and their populations in those sediments were correlated with pore-water ammonium concentrations. Populations of heterotrophic bacteria in 60% of the sediments were greater than 1,000,000 colony forming units (CFU)/g dry sediment and were typically lower in sediments of high clay content and low pH. Microaerophilic N2-fixing bacteria were cultured from > 50% and bacteria capable of growth on H2 were cultured from 35% of the subsurface sediments examined. Clay content was found to be inversely related to bacterial populations. Sediment texture, which controls porosity, water potential, and hydraulic conductivity, appears to be a major factor influencing microbial populations in coastal plain subsurface sediments. (Author's abstract)
W90-02121

AEROBIC METABOLIC POTENTIAL OF MICROBIAL POPULATIONS INDIGENOUS TO DEEP SUBSURFACE ENVIRONMENTS.
Battelle Pacific Northwest Labs., Richland, WA.
R. J. Hicks, and J. K. Fredrickson.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 67-77, 1989. 1 fig, 3 tab, 34 ref. DOE Grant DE-AC06-76RLO 1830.

Descriptors: *Microorganisms, *Sediment analysis, *Bacteria, Regression analysis, Clays, Metabolism, Hydrogen ion concentration.

Subsurface sediment samples, collected from three boreholes ranging in depths from 0.1 to 260 m, were used in substrate mineralization studies to examine the aerobic metabolic potential of microbial populations indigenous to the deep subsurface. Mineralization was measured by quantifying the amount of CO2(14) released from radiolabeled acetate, phenol, or 4-methoxybenzoate added to subsurface sediments at 10 micro/g. Mineralization of the three compounds was observed in all but a few of the subsurface samples and did not decrease with depth. In addition, mineralization data collected from similar geologic formations from the different boreholes indicated that there was significant lateral continuity of microbial activity. Regression analyses were performed to determine which environmental factors were related to microbial metabolic potential. Mineralization was positively correlated with heterotrophic abundance as measured by plate counts. Other parameters that appeared to influence metabolic potential included pH and clay content. (Author's abstract)
W90-02122

MICROBIAL ACTIVITIES IN DEEP SUBSURFACE ENVIRONMENTS.
Tennessee Univ., Knoxville. Inst. for Applied Microbiology.
T. J. Phelps, E. G. Raione, D. C. White, and C. B. Fliermans.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 79-91, 1989. 2 fig, 4 tab, 29 ref. DOE Contract DE-AC09-76SR00001.

Descriptors: *Microorganisms, *Sediment-water interfaces, *Cores, *Bacteria, *Soil profiles, *Sediment analysis, Boreholes, Carbon radioisotopes, Lipids, DNA, Glucose, Surface soils, Sand, Clays.

Activities of microorganisms residing in terrestrial deep subsurface sediments were examined in 46 sediment samples from three boreholes. Radiolabeled time course experiments assessing in situ microbial activities were initiated within 30 min of core recovery. (l-C14)Acetate incorporation into lipids, (methyl-3H)thymidine incorporation into DNA, (2-14C)acetate, and (U-14C)glucose mineralization in addition to microbial enrichment and enumeration studies were examined in surface and subsurface sediments. Surface soils contained the greatest biomass and activities, followed by the shallow aquifer zones. Water-saturated subsurface sands exhibited three to four orders of magnitude greater activity and culturable microorganisms than the dense clay zones, which had low permeability. Regardless of depth, sediments that contained more than 20% clays exhibited the lowest activities and culturable microorganisms. (Author's abstract)
W90-02123

AEROBIC AND ANAEROBIC MICROBIAL ACTIVITY IN DEEP SUBSURFACE SEDIMENTS FROM THE SAVANNAH RIVER PLANT.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
E. L. Madsen, and J. M. Bollag.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 93-116, 1989. 3 fig, 16 ref. DOE Subsurface Transport Program DE-FG02-87 ER60556 and E.I. duPont de Nemours and Company Grant AX 0720809.

Descriptors: *Sediment analysis, *Microorganisms, *Bacteria, Methane bacteria, Cores, Sulfur bacteria, Carbon radioisotopes, Anaerobic bacteria, Glucose, Aerobic bacteria.

Methanogenesis, sulfate reduction, and rates of carbon mineralization were determined for samples derived at different depths from four cores drilled at the Savannah River Plant, Aiken South Carolina. Three gram subsamples of the sediments were dispensed to 10-ml serum bottles under 5% H2/95% N2 and amended with 0.5 mL degassed distilled water with or without the following solutes: formate plus acetate, bicarbonate, lactate, and radiolabeled sulfate, glucose, and indole. After incubating 1 to 5 days, the sediments were assayed for methane, H2, 35S, and 14CO2. No methanogenesis was detected at any depth in any core and sulfate was rarely reduced. Evolution of 14CO2 from glucose and indole was detected in sediments as deep as 262 and 259 m, respectively. At some depths the 14CO2 evolution rate was comparable to that of surface soils; however, at other depths no 14CO2 evolution could be detected. Injection of sterile air into anaerobic incubations increased rates of carbon mineralization at all depths that had demonstrated anaerobic activity and stimulated mineralization activity in sediments that were inactive anaerobically, suggesting a predominance of aerobic metabolism. Increasing the concentration of added glucose and indole often increased the resulting rates of 14CO2 evolved from these substrates. The data indicate that both aerobic and anaerobic microorganisms are present and metabolically active in samples from deep subsurface environments. (Author's abstract)
W90-02124

DENITRIFICATION IN DEEP SUBSURFACE SEDIMENTS.
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
A. J. Franis, J. M. Slater, and C. J. Dodge.
Geomicrobiology Journal GEJODG, Vol. 7, No. 1/2, p 103-116, 1989. 2 fig, 4 tab, 26 ref. DOE Contract DE-ACJ02-76CH00016.

Descriptors: *Bacteria, *Microorganisms, *Sediment analysis, *Soil profiles, *Denitrification, Acetylene blockage technique, Sand, Clays, Organic carbon, Nitrates.

Dissimilatory nitrate reduction (denitrification) in subsurface sediments by indigenous microflora was investigated in samples obtained over a range of depths from 0 to 289 m. Denitrifying activity in sediment samples retrieved from similar stratigraphic horizons at four different sites was determined by measuring the accumulation of N2O using the acetylene blockage technique. Denitrification was detected in unamended samples which received only prereduced deionized water at almost all depths in all sediments samples. The surface sediments showed the highest denitrification activity. In the deeper sediments, denitrifying activity was much higher in saturated sandy samples and lower or absent in drier clay samples. Addition of nitrate enhanced denitrification activity in all samples from below the water table down to the maximum depth sampled (289 m), while addition of a carbon (succinate) source in general had no stimulatory effect. These results show that denitrifying microorganisms were present in all of the deep subsurface sediments tested in this study. Furthermore, these results suggest that adequate supplies of metabolizable organic carbon were

available to support denitrifying activity. However, denitrification may be limited by inadequate supplies of nitrate in the sediments. (Author's abstract)
W90-02125

INTERLABORATORY METHODS COMPARISON FOR THE TOTAL ORGANIC CARBON ANALYSIS OF AQUIFER MATERIALS.
Northrop Services, Inc., Ada, OK.
R. M. Powell, B. E. Bledsoe, G. P. Curtis, and R. L. Johnson.
Environmental Science and Technology ESTHAG, Vol. 23, No. 10, p 1246-1249, Oct 1989. 4 fig, 3 tab, 9 ref.

Descriptors: *Aquifer characteristics, *Path of pollutants, *Comparison studies, Laboratory methods, Organic carbon, Chemical analysis.

The total organic carbon (TOC) content of aquifer materials has been found to have significant effects on the movement of pollutants in the subsurface environment. Accurate quantification of TOC is therefore of great importance to research in groundwater contamination. However, large discrepancies have been observed when laboratories employing different methods determine TOC on the same aquifer material. This study was undertaken to evaluate the extent of these differences and examine their causes. Five subsurface samples were distributed and analyzed for both total carbon and total organic carbon by several instrumental techniques at four laboratories. Results indicate that when the material is adequately prepared with regard to homogeneity and removal of carbonate minerals, reasonably comparable values are obtained for all the instruments used, with the exception of a wet oxidation technique that is insufficiently oxidizing. Trends in subsurface research indicate a need for methods with improved accuracy and precision to lower detection limits and increase reliability. These methods will require standardization of analytical techniques, particularly sample preparation. (Author's abstract)
W90-02141

INTERPRETATION OF OSCILLATORY WATER LEVELS IN OBSERVATION WELLS DURING AQUIFER TESTS IN FRACTURED ROCK.
Geological Survey, Reston, VA.
A. M. Shapiro.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2129-2137, October 1989. 10 fig, 2 tab, 17 ref.

Descriptors: *Groundwater movement, *Pumping tests, *Observation wells, *Aquifer testing, *Water level, *Water level fluctuations, Model studies, Fractured formations, Fluid movement.

Oscillatory water levels in observation wells have commonly been recorded at the beginning of aquifer tests in highly transmissive fractured formations. In this study, oscillatory water levels are predicted by the equations coupling the fluid movement in the observation well and the fluid movement in the surrounding formation. The equivalent-porous medium and dual-porosity models of fractured rock are two models considered in this analysis; however, other conceptual models of fractured media can also be coupled with the model presented here for fluid movement in the observation well. Type curves for the response of water levels in observation wells due to pumping in another well are generated by numerical inversion of the Laplace transform solution to the governing equations. Overdamped conditions, where inertial effects are insignificant, and underdamped conditions, where oscillations arise, are predicted by the solution to the governing equations. By matching water level measurements with the appropriate type curve, a conceptual model of the formation can be identified, and aquifer properties can be estimated. This analysis is applied in the interpretation of an aquifer test conducted in a fractured dolomite in northeastern Illinois. If the early time oscillation are ignored, the measured water levels can be explained by an equivalent-porous medium model. By analyzing the early time oscillations, however, the formation is shown to respond as a dual-porosity medium with a storativity of the fracture porosity that is an order of magnitude smaller than the storativity estimated from the equivalent-porous medium model. (Author's abstract)
W90-02191

SOURCES OF ACIDIC STORM FLOW IN AN APPALACHIAN HEADWATER STREAM.
Pennsylvania State Univ., University Park. Program in Ecology.
For primary bibliographic entry see Field 5B.
W90-02192

DENSITY-DRIVEN FLOW OF GAS IN THE UNSATURATED ZONE DUE TO THE EVAPORATION OF VOLATILE ORGANIC COMPOUNDS.
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5B.
W90-02194

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 1. DERIVATION OF A DYNAMIC MODEL.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-02195

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 2. APPLICATION OF MODEL IDENTIFICATION TO THE RIVER MURRAY.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 5B.
W90-02196

CONSISTENT SET OF PARAMETRIC MODELS FOR THE TWO-PHASE FLOW OF IMMISCIBLE FLUIDS IN THE SUBSURFACE.
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W90-02197

RELIABLE AQUIFER REMEDIATION IN THE PRESENCE OF SPATIALLY VARIABLE HYDRAULIC CONDUCTIVITY: FROM DATA TO DESIGN.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
For primary bibliographic entry see Field 5G.
W90-02200

MULTIOBJECTIVE SAMPLING DESIGN FOR PARAMETER ESTIMATION AND MODEL DISCRIMINATION IN GROUNDWATER SOLUTE TRANSPORT.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7A.
W90-02202

ISOTOPIC INVESTIGATION OF GROUNDWATER IN THE CENTRAL SAN JUAN BASIN, NEW MEXICO: CARBON 14 DATING AS A BASIS FOR NUMERICAL FLOW MODELING.
New Mexico Inst. of Mining and Technology, Socorro. Geophysical Research Center.
F. M. Phillips, M. K. Tansey, and L. A. Peeters.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2259-2273, October 1989. 13 fig, 5 tab, 41 ref. New Mexico Water Resources Research Institute Grants WRRI-1345668 and WRRI-1423606.

Descriptors: *Isotope studies, *Geohydrology, *Aquifers, *Solute transport, *Groundwater movement, *Carbon radioisotopes, Model studies, New Mexico, Flow models, Piston flow models, Vertical flow.

Carbon 14 dating of groundwater can be used to help determine the transmissivity distributions of aquifers. This method may offer significant advantages, in certain respects, over traditional aquifer pumping test techniques. Carbon 14 dating has been applied to a hydraulic analysis of a multilayer aquifer system in the central San Juan Basin of New Mexico. After corrections for geochemical evolution of the solutes, the influence of dispersive processes on the C14 distribution was investigated. A model incorporating stochastic dispersion theory indicated that macroscopic dispersion exerted only a small influence on the measured C14 activities. The C14-derived transmissivity distribution was used to construct a numerical flow model which was applied to an analysis of interaquifer leakage. The model showed that even though vertical flow between aquifers was significant, in this case it did not cause the C14 distribution to differ significantly from that predicted by a simple piston flow model. Carbon 14 can be used as a basis for detailed hydraulic evaluations of groundwater flow in areas where traditional well hydraulics methods are not practical. (Author's abstract)
W90-02203

INTERPRETATION OF THE DIFFERENCE BETWEEN APERTURE ESTIMATES DERIVED FROM HYDRAULIC AND TRACER TESTS IN A SINGLE FRACTURE.
Notre Dame Univ., IN. Dept. of Civil Engineering.
S. E. Silliman.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2275-2283, October 1989. 9 fig, 3 tab, 31 ref. Dept. of Int. USGS award 14-0001-G1477.

Descriptors: *Groundwater movement, *Fracture permeability, *Tracers, *Hydraulic permeability, Flow, Apertures, Variability, Channeling, Anisotropy.

Recent field efforts involving testing of single fractures indicate that hydraulic and tracer tests provide different estimates of fracture aperture. It is argued that this behavior is a result of the averaging involved in the use of the cubic law for these tests. This argument leads to the following predictions for slow flow through variable aperture fields: (1) for flow parallel to aperture channeling the aperture estimate from a tracer test will be greater than the estimate from a hydraulic test; (2) for flow perpendicular to aperture channeling the tracer test provides the smaller estimate; and (3) for flow in isotropic aperture fields the tracer test again provides the smaller aperture estimate. Lognormally distributed aperture fields are used to demonstrate the magnitude of aperture variability which may be observed under three flow geometries. It is noted that the maximum difference between aperture estimates occurs when the variance of the aperture distribution is large, a result which is consistent with other studies of random aperture fields. Finally, it is suggested that the relative variation of the aperture estimates may provide a means whereby the orientation of anisotropy or channeling may be identified. (Author's abstract)
W90-02204

CONTINUOUS SEISMIC-REFLECTION SURVEY OF THE GREAT SALT LAKE, UTAH-EAST OF ANTELOPE AND FREMONT ISLANDS.
Geological Survey, Salt Lake City, UT. Water Resources Div.
P. M. Lambert, and J. C. West.
Available from Books and Open-File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 88-4157, 1989. 17 p, 6 fig, 1 plate, 15 ref.

Descriptors: *Stratigraphy, *Geohydrology, *Great Salt Lake, *Seismic studies, *Aquifers, Alluvium, Bedrock, Faults.

A continuous seismic-reflection survey of the Great Salt Lake, Utah, was conducted east of Fremont and Antelope Islands in 1984 by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources and produced data along approximately 80 miles of seismic lines. The survey was conducted to determine depth to consolidated rock, and definition and continuity of

overlying basin fill under the lake. Interpretation of the data indicates the presence of faulted rock dipping away from Fremont and Antelope Islands. A north-south-trending consolidated-rock ridge is identified 200 ft below lake bottom, 275 miles east of Fremont Island. Shallow rock is also inferred 380 ft below lake bottom, near Hooper Hot Springs, and 520 ft below lake bottom approximately 4 miles east of the south end of Antelope Island. Interpretation of reflections from overlying basin fill indicates fine-grained, thinly-bedded deposits that become coarser with depth. Strong reflectors in the basin fill can be correlated with water-bearing strata penetrated by wells near the north end of Antelope Island and along the east shore of the lake. Many continuous, high-amplitude reflections can be identified in data from basin fill and may represent sedimentary sections or aquifer boundaries but cannot be defined because of a lack of subsurface control in the area. (USGS)
W90-02271

HYDROCHEMICAL AND ISOTOPIC STUDY OF THE GROUNDWATER OF THE BOTUCATU AQUIFER IN SAO PAULO STATE (ESTUDO HIDROQUIMICO E ISOTOPICO DAS AGUAS SUBTERRANEAS DO AQUIFERO BOTUCATU NO ESTADO DE SAO PAULO).
Sao Paulo Univ. (Brazil). Inst. de Geociencias.
R. B. G. Silva.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-702796/GAR. Price codes: A07 in paper copy, A01 in microfiche. INIS-BR-1100, 1983. 147p, 23 fig, 9 (sheets) maps, 6 tab, 80 ref. English summary.

Descriptors: *Geochemistry, *Water chemsitry, *Groundwater dating, *Groundwater, *Brazil, *Aquifers, Magnesium, Sodium bicarbonate, Chloride, Sulfate, Isotopic tracers.

The process controlling chemical composition of groundwater, its origin and apparent age, as well as the natural flow rate of the water in Botucatu aquifer in the state of Sao Paulo, Brazil, have been investigated using hydrochemical and environmental isotopic 018, H2, C13, C14 techniques. The main recharge process is assumed to be the infiltration of rain water in the aquifer outcrop area. The confining conditions and temperature increase increasing depth of the top of the aquifer layer. The recent magnesium and sodium bicarbonated waters change with increasing age to sodium bicarbonate and then to sodium chloride-sulfated waters; the oldest found in the research area are around 30,000 years old. The mean Darcy permeability estimated on the basis of C14 and hydraulic gradient data is 0.26 Mm/s. (Author's abstract)
W90-02273

MODELLING OF LARGE-SCALE HEAT AND CONTAMINANT TRANSPORT IN GROUND WATER. DFG RESEARCH GROUP AT THE UNIVERSITIES OF HOHENHEIM, KARLSRUHE AND STUTTGART--REPORT OF ACTIVITIES 1986/87 (MODELLIERUNG DEES GROBRAUMIGEN WARME-UND SCHADSTOFFTRANSPORTS IM GRUNDWASSER. DFG FORSCHERGRUPPE AN DEN UNIVERSITAETEN HOHENHEIM, KARLSRUHE UND STUTTGART--TATIGKEITSBERICHT 1986/87).
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 5B.
W90-02278

KARST HYDROGEOLOGY AND KARST ENVIRONMENT PROTECTION.
Vol. 1. Proceedings of the 21st Congress of the International Association of Hydrogeologists, Guilin, China, 10-15 October 1988. International Association of Hydrogeological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. IAHS Publication No. 176. 552p.

Descriptors: *Water pollution control, *Karst, *Karst hydrology, *Aquifers, *Geology, Geological surveys, Geologic formations, China, Europe, United States, Latin America, Africa, Geologic mapping, Groundwater, Conferences.

This volume contains 263 contributions covering very broad karst areas of Asia, Europe, America, Africa and Latin America that were presented at the International Association of Hydrogeologists 21st Congress, held in Guilian, China, October 10-15, 1988. The research reflect the latest achievements in theoretical and applied research, as well as advanced methods and techniques. A number of papers attempt to link the hydrogeological problems of some karst regions with the environmental systems. Development and protection of karst regions are also discussed. Topics include: Strategy of comprehensive planning and development of karst areas; Regional karstology; Regional distribution patterns and systematic analysis of karst groundwater; Parametric study of karst groundwater; Assessment of water resources; Investigation techniques and the application of mathematical models; Rational development, management and protection of karst and fissure groundwater; Forecast and control of surface collapse; and Hydrogeological mapping of karst areas and hydrogeological problems in non-karst areas. (See W90-02445 thru W90-02506) (Mertz-PTT)
W90-02444

RESEARCH ON HYDROGEOLOGY IN KARST REGIONS OF CHINA.
Academia Sinica, Beijing (China). Inst. of Geology.
S. Zhang, K. Xin, and C. Ji.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 1-9. 12 ref.

Descriptors: *Karst, *Karst hydrology, *Geological surveys, *Geologic mapping, *Geohydrology, *China, *Carbonate rocks, Groundwater, Land use.

The carbonate rock outcropping within China cover an area of more than one eighth of the whole territory. Rapid progress has been made both in the theory and practice of karst geosciences. Since 1961, six national symposia on karstology have been held in China, and Karst is researched in combination with many other sciences. Stratigraphical sections have been made for almost all areas covered by carbonate rocks and are used successfully in the research on karst development in China. Regional hydrogeologic investigation and mapping have been conducted in most karstic areas, and 145 international sheets of hydrogeological maps on a scale of 1:200,000 have been published. This work has provided the basis for the hydrogeologic planning, and evaluation of ground water resources and land use planning. (See also W90-02444) (Mertz-PTT)
W90-02445

HYDROGEOLOGY OF MOUNTAIN KARST.
Akademiya Nauk Gruzinskoi SSR, Tiflis. Sector of Hydrogeology and Engineering Geology.
G. I. Buachidze, and T. Z. Kiknadze.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 10-16. 2 fig, 20 ref.

Descriptors: *Geohydrology, *Groundwater pollution, *Aquifers, *Karst, *USSR, *Karst hydrology, Carbonate rocks, Mountains, *Groundwater, Water pollution.

On the basis of historical review and elucidation of the specific tasks and methods of study it is demonstrated that the hydrogeology of karst can be singled out as an independent branch of science. It is shown that karst strip at the Southern Slope of the Great Caucasus has the peculiar hydrogeological features of mountain karst and that Georgia may be used as a standard when considering some basic aspects of mountain karst hydrogeology. The carbonate deposits occupy an area up to five thousand square kilometers, and the karst strip is 320 km long and 5.35 km wide. The karst waters, due to their specific features and high flow rates in open systems, without natural filters, are polluted more easily and intensively than other types of subterranean waters. Possible contamination of feeding zones becomes even more dangerous within the areas of denuded karst. Hence, it is necessary to determine precisely the feeding zones of karst springs by means of water tracing methods and to declare them the reserves. (See also W90-02444) (Mertz-PTT)
W90-02446

ENVIRONMENTAL AND ENGINEERING EFFECTS OF SINKHOLES--THE PROCESSES BEHIND THE PROBLEMS.
Florida Sinkhole Research Inst., Orlando.
B. R. Beck.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 17-29. 5 fig, 17 ref.

Descriptors: *Subsidence, *Karst hydrology, *Karst, *Geologic erosion, *Florida, Limestone, Sinks, Land development.

Karstic erosion of the land surface is controlled by processes occurring in the epikarstic zone--the upper portion of the limestone which is most intensely dissolved. Sinkholes developing today are generally the effects of downward movement of mantling sediment into the major karren shafts which drain the epikarstic zone deeper into the true karstic aquifer, but dissolution of the limestone itself does not cause significant changes in the human life span. This downward erosion of mantling sediment is termed ravelling. In uniform sediment an arched cavity will occur while in unconsolidated sediment which is stratified, lateral tunnelling may occur. Only the major karren can transmit sediment downward, the majority are ineffective. In mantled karst the location of surficial depressions and photo-linears does not necessarily correlate to areas of new collapse. The irregular and highly dissolved character of the epikarstic zone complicates foundation engineering since downward drainage through this zone may be limited and cause flooding. An understanding of these processes in the epikarstic zone is essential for developing on karst. (See also W90-02444) (Author's abstract)
W90-02447

KARST ENVIRONMENTAL SYSTEM.
Institute of Karst Geology, Guilin (China).
D. Yuan.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 30-46. 7 fig, 2 tab, 9 ref.

Descriptors: *Karst, *Karst hydrology, Environmental quality, Groundwater quality, Groundwater pollution, Land development.

There are many particular environmental problems in karst regions, such as drought, flood, deforestation, surface collapses, gushes of water and mud into mining tunnels, groundwater pollution, as well as damage to scenic areas. A lot of work has been done to deal with their origin, evolution, and to develop remedial measures to mitigate them, with some success. However, some environment problems in karst regions have long existed and have remained unsolved, despite great efforts made in trying to treat them. New problems arise and identical problems may appear in the neighboring regions. The reasons for such phenomena are believed to be a lack of knowledge of the karst environmental system or lack of proper environmental planning, strategic decision and effective management based on the karst environmental system reviewed. The formation, characteristics and types of karst environment system are reviewed. Many kinds of important resources may occur within a karst environment system and remain in a dynamic equilibrium. The exploitation of these resources will inevitably change this natural equilibrium. It is necessary to take into account the characteristics of the karst environmental

system, and its environmental capacity and quality, in order to fit the long term needs of human beings in various respects. (See also W90-02444) (Author's abstract)
W90-02448

ASSESSMENT AND DEVELOPMENT--MANAGEMENT PATTERNS OF KARST WATER RESOURCES IN CHINA.
Ministry of Geology and Mineral Resources, Beijing (China). Bureau of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 6D.
W90-02449

ENVIRONMENTAL ISOTOPE IDENTIFICATION OF CATCHMENT AREAS IN KARST.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
M. A. Geyh, G. Michel, and W. Wagner.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 58-63. 2 fig, 1 tab, 12 ref.

Descriptors: *Tracers, *Groundwater movement, *Karst, *Radioisotopes, *Karst hydrology, *Catchment areas, Springs, Groundwater.

Environmental stable radioisotopes were used to identify catchment areas of karst springs. The elevation of mountainous catchment areas was estimated on the basis of the temperature gradient of the empirically determined values of spring water. The size of a catchment area was a function of the mean residence time of the spring water, the mean annual spring discharge, the porosity, and the thickness of the aquiferous rock. The mean residence time was calculated by applying an exponential model to the stable and radioactive isotope values. The boundaries of the catchment areas of karst spring could estimate the initial radiocarbon content, which was determined with the same model. Moreover, the stable carbon isotope value could be used to differentiate between karst water and groundwater of other origin. In confined karst aquifers, long-term monitoring of the stable oxygen values of the groundwater may aid study of the complex distribution of residence times of various components in connection with the groundwater budget. (See also W90-02444) (Author's abstract)
W90-02450

HYDROLOGICAL ENVIRONMENTS AND WATER RESOURCE PATTERNS IN KARST REGIONS OF CHINA.
Zhengding Inst. of Hydrogeology and Engineering Geology (China).
Y. Lu.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 64-75, 7 fig, 2 tab.

Descriptors: *Geohydrology, *Karst hydrology, *Karst, *China, *Water resources development, Geological surveys, Hydrology, Groundwater.

In the karst regions of southwest and central-south China there are surface rivers that produce hydroelectric power as well as large underground rivers that have an average discharge of 0.5 cu m/s or greater. In north and northeast China there are fewer surface rivers, but ca. 100 large karst springs with a discharge of 1-16 cu m/s. Buried carbonate rocks cover 70% of the whole area of China. The basic features of karst include: hydrographic nets; transformations between surface and subsurface water; hydrological isotopes; and corrosion and deposition which are greatly influenced by temperature and rainfall. Typical water resources in karst areas in China are: melting snow water springs in high mountains; springs in semi-arid mountains; groundrivers in rainy broad plateaus and mountains; groundrivers in limiting mountain lands; passage systems in peak-forest and peneplains; groundwater in tattered fold basins; passage water in lake basins and far-shore areas; fresh-brackish water in coastal zones; fresh-brackish water in reef islands; passage water in shallowly buried hills; paleo-thermal-mineralized water in settling environments; and paleothermal mineralized water in depressions. (See also W90-02444) (Mertz-PTT)
W90-02451

ARTIFICIAL UNDERGROUND RESERVOIRS IN THE KARST EXPERIMENTAL AND PROJECT EXAMPLES.
Energoprojekt, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 8A.
W90-02452

GROUNDWATER QUALITY MONITORING AS A TOOL OF GROUNDWATER RESOURCES PROTECTION.
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5A.
W90-02453

DISTRIBUTION OF KARST GROUNDWATER IN SOUTHERN PART OF DUSHAN, GUIZHOU PROVINCE AND ITS EXPLOITATION AND MANAGEMENT.
Guizhou Inst. of Tech., Guiyang (China).
J. Li, J. Mao, G. Yan, and Z. Mei.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 115-123. 3 fig, 2 tab, 2 ref.

Descriptors: *Geohydrology, *Water resources development, *Groundwater management, *Karst hydrology, *China, *Karst, Model studies, Groundwater depletion.

Through an analysis of the dynamics of groundwater; the structure, occurrence, runoff and changes with space and time of the karst aquiferous system in response to development in the Dushan area of China was determined. A model of groundwater planning and management was designed that determined the features of the karst water regime in regard to recharge, runoff, and discharge; variations in the natural reserve of karst groundwater; and an analysis of fluctuation tendancies in the groundwater. According to the distribution and storage of karst groundwater, a set of multi-purpose utilization methods was developed and applied in order to bring about both social and economic benefits. These methods determine how the karst water can be used for irrigation, hydraulic power generation and drinking water using specified water retaining, channeling, pumping, draining and well digging techniques. (See also W90-02444) (Mertz-PTT)
W90-02456

CHARACTERISTICS OF KARST WATER--IMPREGNATED ORE DEPOSITS IN CHINA AND THE COMBINATION BETWEEN MINE-DEWATERING AND WATER SUPPLY.
Ministry of Geology and Mineral Resources, Beijing (China).
K. Xin, P. Yu, and G. Ye.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 128-134. 2 fig, 2 ref.

Descriptors: *Karst hydrology, *China, *Water resources development, Groundwater, Karst, Mining engineering.

Carbonate rocks are widely distributed over China. Karstic water is the main source both of water-filling in mines, and of water supply. Surface collapse occurs frequently in the karst water-impregnated ore area of China, where collapses occurred in 94 localities. Surface collapses are controlled by the developmental pattern of karst, and often occur in areas where the Quaternary thickness is less than 30 m and the shallow karst is well developed in regard to groundwater activity, or is located near the tectonoclastic zone in river beds, swamp land, and depressions. The natural collapse phenomenon observed in the karst water-impregnated coal mine in North China is unique. The practice of combining dewatering with water supply could not only reduce the damage of karst water to the mining of ore deposits, but could also be used as a water supply source and provide economic and social benefits in North China. This combination technique must be carried out in accordance with the specific local conditions in regard to: (1) which is the predominant use; (2) environmental conditions; (3) the quantity and quality of the water; and (4) a monitoring system. (See also W90-02444) (Author's abstract)
W90-02457

KARST ENVIRONMENTAL EFFECT OF WATER-CONSERVANCY AND WATER-ELECTRICITY PROJECTS IN MOUNTAIN AREAS OF GUIZHOU, CHINA.
Guizhou Provincial Bureau of Water Conservancy and Electric Power, Guiyang (China).
For primary bibliographic entry see Field 4C.
W90-02458

KARST ENVIRONMENT OF GUIYANG CITY--ITS MANAGEMENT AND PROTECTION.
The NO. 1 Hydrogeology and Engineering Geology Party of Guizhou, Guiyang, China.
For primary bibliographic entry see Field 4B.
W90-02460

PREDICTION AND RATIONAL DEVELOPMENT AND UTILIZATION OF UNDERGROUND WATER RESOURCES IN HAIQUAN OF HUNAN PROVINCE.
The No.1 Hydrogeological and Engineering Geological Party of Hunan Province, China.
Q. Sun, and H. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 161-169. 4 fig, 4 tab.

Descriptors: *Groundwater management, *Water resources development, *China, *Karst hydrology, Finite difference methods, Correlation analysis, Mathematical studies, Land use, Groundwater potential.

Based on historical data of precipitation in Chenzhou recorded in the past 34 years by the Meteorological Station at Chenzhou and a large number of data obtained from hydrogeological reconnaissance, prediction and forecasting of the groundwater resources and the regime of water levels in Haiquan were made using the correlation analysis and the finite-difference technique. According to the prediction of precipitation and infiltrative precipitation recharge as well as the forecasting of the regime of groundwater levels, it is quite possible to increase the exploitation rate in Haiquan from 10000 cu m/day at present to 20851 cu m/day or even to 30000 cu m/day. A comparison of the exploitation rate of 20851 cu m/day and 30000 cu m/day with the corresponding recharge rate in 1990 and 2000 in Haiguan shows that the recharge in 1990 and 2000 will somewhat decrease as compared with that in 1983, but the infiltrative precipitation recharge in 2000 will still be 3.90 times the exploitation, and therefore the groundwater exploitation rate of 30000 cu m/day will be maintained in 2000. (See also W90-02444) (Author's abstract)
W90-02461

ENVIRONMENTAL PROBLEMS AND INVESTIGATIONS IN THE KARST AREAS OF AUSTRIA.
Naturhistorisches Museum, Vienna (Austria). Karstological and Speleological Dept.
H. Trimmel, and R. Pavuza.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 172-177. 4 fig, 4 ref.

Descriptors: *Groundwater pollution, *Water pollution sources, *Karst hydrology, *Groundwater management, *Geological surveys, *Geologic mapping, *Austria, Karst, Land use, Agricultural hydrology, Groundwater quality, Environmental effects, Forest hydrology.

About 15% of the entire territory of Austria can be classified as Karst. As a result of extensive tourism, stock farming and forestry some problems arise in several areas. This is of particular significance as a substantial amount of the drinking water in Austria originates from karst regions. Special maps from the past ten years point out the environmental factors of selected Austria karst areas. About 10% of the Austrian karst is currently being mapped. These maps consist of transparent overlays to the official topographic maps, as well as detailed explanations dealing with geoscientific, environmental and economical factors. The Dachstein region in the Northern Calcareous Alps 220 km southwest of Vienna is an example of groundwater contamination due to intensive tourism. During a thunderstorm period in August 1984 high discharge rates were correlated with high bacteria counts in the Brunnbach-spring. This was indirectly related to the tourist activity in the glaciated area and associated lakes. (See also W90-02444) (Author's abstract)
W90-02462

TAPPING AND PROTECTION OF UNDERGROUND WATER IN THE ADRIATIC KARST REGION RELATED TO THE NEW CONCEPTION OF STRUCTURE OF DINARIDES.
Naturhistorisches Museum, Vienna (Austria). Karstological and Speleological Dept.
B. Biondic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 187-193. 3 fig, 5 ref.

Descriptors: *Geohydrology, *Water resources development, *Karst hydrology, *Yugoslavia, *Carbonate rocks, Groundwater, Monitoring, Environmental protection, Water pollution control.

Geologically, Yugoslavia is primarily karst, with carbonate rocks and a network of underground streams and surface waters. Since water dynamics and the structural framework of the terrain are directly related, the study of structural relations is of primary importance. This is the tectonically very dynamic area of the Dinarides, where tangential structural forms are expressed due to subduction effects, and thus underground waters have very specific dynamics. The underground water flows along the underlying limb of an overthrust towards coastal zones of discharge, and only at springs does it vertically penetrate into the karstified carbonate rocks of the overlying deposits visible at the surface. Advanced knowledge of geohydrological interrelations enables successful tapping of underground water at its source or by penetrating the retention areas tributary to the source. Today most such activity is still related to the zone of permanent outflow, since this region has dependable reserves and a margin of safety for water supply. The great deficiency in recharge of the underground karst during long summer dry periods requires saving part of the high waters during rainy periods in surface storage basins. Future projects involve tapping of water by regulating discharge from the karst-drainage systems. In parallel with water exploitation, water-quality monitoring is carried on, including complex studies of possible biological and chemical pollutants under various hydrogeological conditions in the underground karst. (See also W90-02444) (Mertz-PTT)
W90-02464

PROTECTION OF HIGHLY PERMEABLE AQUIFERS AGAINST CONTAMINATION BY XENOBIOTICS.
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5G.
W90-02465

EFFECTS OF LAND DRAINAGE ON GROUNDWATER RESOURCES IN KARSTIC AREAS OF IRELAND.
Trinity Coll., Dublin (Ireland). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W90-02466

HYDRODYNAMICS AND HYDROCHEMICAL EVOLUTION OF GYPSUM KARST AQUIFERS: DATA FROM THE EMILIA ROMAGNA REGION.
Istituto Italiano di Speleologia, Bologna (Italy).
P. Forti, and F. Francavilla.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 219-224. 4 fig, 6 ref.

Descriptors: *Geochemistry, *Geohydrology, *Karst hydrology, *Italy, *Aquifer systems, Groundwater pollution, Karst, Gypsum, Sulfates, Apennine Mountains.

In Italy evaporitic formations outcrop frequently, mainly along all the Apennine chain from Piemonte to Calabria and in Sicily. These formations are always intersected by large karst phenomena. Some of the most important are located in the Emilia-Romagna region. The principal karst aquifers are: The Spipola-Acqua Fredda cave system near Bologna, the Rio Stella/Rio Basino cave system near Faenza, and the Tanone cave and Poiano salt springs near Villaminozzo. All these karst aquifers are characterized by high flow and discharge rates with sudden variations in their regimens during spring rainfalls. From the hydrochemical point of view, all the karst waters of the Emilia Romagna region are very hard and are fully saturated with respect to sulfate ion; this hinders a direct municipal use of these waters, but nevertheless they represent important local resources for agricultural use. Due to their high flow rates, lack of any possibilities of self-purification, and their potential as storage traps for pollutants, gypsum karst aquifers of the Emilia Romagna region are highly vulnerable to all kinds of pollutants. (See also W90-02444) (Mertz-PTT)
W90-02467

EVOLUTION OF KNICK-POINT BELT IN A RIVER SECTION IN HUANGGUOSHU.
Academia Sinica, Guiyang (China). Karst Research Office.
H. Yang, and P. Li.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 225-232.

Descriptors: *Geomorphology, *Karst hydrology, *Rivers, *China, River beds, Karst, Evolution, Geology.

The river section in Huangguoshu is part of the Dabang River which is a first-order tributary of the North Panjiang River. It is 8 km long, with the north end in Doupo and the south end in Hezuilai. There are 5 knick-points. The top of each knick-point is a rather wide terrace from which waterfalls drop down, and the bottom is a valley. The 5 knick-points are different in process and stage of evolution. According to a regional comparison, this area must have been affected when the Himalayas uplifted. The rivers obtained potential energy from the internal energy of the structural movement and added dynamic energy to erosion. Owing to the tectonics where knick-points occur, the fracturing degree of rock and the different forms of original river beds, there is an obvious difference in their evolution. Only the Huangguoshu knick-point contains the regional features, and is regarded as an erosion datum plane and regionally as geomorphologically distinctive. All the others are structural and lithological knick-points. Therefore, they are of no regional significance in terms of geomorphology. This indicates that different forms of tectonics can be developed simultaneously. The evolution of knick-points is ordered, but it is supposed that all the variables in the system of geomorphologic formation are constants. Under these conditions, ordered evolution comes to a sudden stop, and is replaced by disordered evolution. (See also W90-02444) (Mertz-PTT)
W90-02468

STUDY ON ISOTOPES OF KARST WATER AND TRAVERTINE DEPOSITS AT THE HUANGLONG SCENIC SPOT.
Institute of Karst Geology, Guilin (China).
X. Chen, X. Zhu, and X. Zhu.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 233-240. 3 fig, 1 tab, 2 ref.

Descriptors: *Geochemistry, *Geomorphology, *Karst hydrology, *China, *Travertine, *Isotope studies, *Springs, Carbon radioisotopes, Radioisotopes, Geology, Deuterium, Oxygen isotopes, Uranium, Chemical properties.

The Huanglong Valley is a well-known scenic spot. Through isotopic studies the development mechanism, the formation age, the sedimentation rate of travertine deposits forming the landscape of the Huanglong scenic spot, and the origin of hot springs with low temperature have been determined. Stable isotopes, such as deuterium, oxygen-18 and carbon-13, and radioactive isotopes such as tritium, carbon-14 and uranium were used, and about 30 groups of samples were collected from the Huanglong valley and its surrounding areas. The carbon-14 dating of travertine deposits in this region showed that the sedimentation was a successively layered one. The thickness of travertine deposits was less than 30 m. The sedimentation age of travertine deposits was Holocene, ranging between 8000 and 2000 years. The average sedimentation rate was 3 to 5 mm/yr and the variation range was 0.4 to 33 mm/yr. The carbon-14 datings of the Pearl Spring was 6600+/-100 years and the Feicui Spring was 6400+/-185 years. This showed that their formation ages were close to one another, but the Pearl Spring was deeper. (See also W90-02444) (Mertz-PTT)
W90-02469

KARST DEVELOPMENT IN PERMAFROST REGIONS OF NORTHERN CANADA.
Carleton Univ., Ottawa (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2J.
W90-02470

EVOLUTION OF KARST AND ITS PRACTICAL SIGNIFICANCE IN HYDROGEOLOGICAL INVESTICATION.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
J. Silar.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 264-267. 7 ref.

Descriptors: *Karst hydrology, *Geohydrology, *China, *Carbonate rocks, *Geomorphology, Groundwater movement, Evolution, Geology.

Karstification is a relatively fast exogenic process which depends on geological and morphological evolutions. The otherwise continuous evolution of karst including its hydrogeological structures has often been rejuvenated and acelerated by tectonic uplifts which intensified the ground-water circulation within the soluble rock due to the increased hydraulic gradient, or on the contrary, it has been retarded or stopped by subsidence of the area and by the subsequent decline of ground-water circulation. Sometimes, the karst of the previous geological periods was buried under the sediments deposited later. Thus, the geological and morphological analyses of evolution are significant for providing ideas on the present-day spatial arrangement of ground-water circulation. They are useful in the

first phases of hydrological investigation for ground-water development as well as for the designing of reservoirs in carbonate rocks. Examples from the karst region in South China and other regions in the world indicate that the study of geological features and of their evolution in the past provides a clue for the interpretation of the present-day hydrogeological structures. (See also W90-02444) (Author's abstract)
W90-02471

RELATION BETWEEN THE HYDROGEOLOGY OF CARBONATE ROCKS AND THE DEVELOPMENT OF KARST LANDFORMS.
Geological Survey, Nashville, TN.
J. V. Brahana, and E. F. Hollyday.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 270-275. 1 fig, 1 tab, 4 ref.

Descriptors: *Geomorphology, *Karst hydrology, *Geohydrology, *Karst, *Carbonate rocks, *North America, *Caribbean Sea, Groundwater movement, Mathematical analysis, Evolution.

Hydrogeologic processes and controls affecting aquifer porosity, permeability and subsequent karst landform development can be separated into six general categories: (1) diagenetic-geochemical; (2) lithologic-stratigraphic; (3) structural-tectonic; (4) hydrologic; (5) weathering geomorphic; and (6) historical geologic-chronologic. While the relative importance of these processes and controls may vary regionally, the development of karst landforms are the cumulative result of the interrelation of hydrologic and geologic processes and controls unique to individual carbonate terranes. In an effort to better understand the relation between the hydrogeology of carbonate rocks and subsequent landform development, a matrix tabulation method quantifying processes and controls (causes), and resultant landform (effects) was applied to 27 carbonate terranes in North American and the Caribbean. Results indicate that dissolution and dynamic ground-water flow are the dominant causes affecting karst landform development. Many other processes and controls may also be important and results indicate that none should be omitted from consideration. (See also W90-02444) (Author's abstract)
W90-02472

HYDROLOGICAL CONTROL AND THE DEVELOPMENT OF COCKPIT AND TOWER KARST.
Auckland Univ. (New Zealand). Dept. of Geography.
P. W. Williams.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 281-290. 5 fig, 27 ref.

Descriptors: *Geomorphology, *Tower karst, *Karst, *Karst hydrology, *Geohydrology, Evolution, Cockpit karst.

Controversy still exists concerning the evolution of tower karst (fenglin), in particular its relationship to cockpit or cone karst (Fengcong). Two hypotheses for tower karst development are examined: (1) that it evolves directly; and (2) that it evolves from a previous cockpit karst phase. The development of karst is strongly influenced by its hydrological setting and particularly by the relationship of the karstic rock to its non-karstic surrounds. This determines whether the influence of diffuse autogenic or concentrated allogenic recharge is the most dominant in the erosion of the relief. Given pure dense limstones and a humid warm to mild climate, diffuse autogenic recharge will result in the development of draw-down dolines and a polygonal karst relief, whereas concentrated recharge from allogenic streams will lead to the formation of point recharge depressions. Allogenic recharge through a breached caprock forms centripetally draining, roughly circular streamsink depressions, whereas lateral allogenic input along a recharge margin develops elongate depression such as blind valleys. When a caprock is completely removed by erosion, the recharge over the karst becomes diffuse and autogenic. This is the case in most cockpit karsts. It is concluded that both occur but that the evolution from a previous cockpit karst phase is the more common case. The transition from cockpit to tower karst is forced when the water-table is reached; an important hydrologic threshold that controls the operation of natural processes. A major fall in the water-table as a consequence of uplift and rejuvenation causes tower karst to revert to cockpit karst, but a minor or gradual lowering of the water-table promotes the growth of towers by extension of their bases. (See also W90-02444) (Mertz-PTT)
W90-02474

SPELEOLOGICAL EXPLORATION OF OGULIN AREA.
Student Mountaineering Society, Zagreb (Yugoslavia).
E. Kireta, and M. Kovacic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 291-198. 5 fig, 3 ref.

Descriptors: *Geomorphology, *Caves, *Karst hydrology, *Karst, *Yugoslavia, Groundwater movement, Groundwater pollution, Geology, Cretaceous, Permeability.

Ogulin zavala is a part of karst area in the northwestern part of Yugoslavia. The area is divided into permeable and impermeable parts according to hydrogeological properties of rocks. A comparison of the geological and hydrogeological draft indicates that the biggest part of underground water flow is in the lower Cretaceous layers. Older layers are impermeable to surface water (the upper impounding area). The spring formations of the underground rivers in the lower Cretaceous limestone (the lower impounding area) are believed to be caused by a high groundwater level in this area. Speleological explorations in the so called lower intake area have discovered and explored big caves. Water is a main factor in forming these caves and is present at all times of the year. Water levels often increase rapidly during heavy rainfall and spring thaws, and water levels are lowest in August and September and in the winter. There are signs of severe pollution in some of these underground water systems from the town of Ogulin which is situated above part of the cave network. Based on general hydrogeological characteristics as well as speleological explorations, it is believed that an even bigger cave system and underground water network exists in this area. (See also W90-02444) (Mertz-PTT)
W90-02475

SOME CHARACTERISTICS OF SILT OF SUBTERRANEAN SYSTEM OF DJULA-MEDVEDICA IN OGULIN YUGOSLAVIA.
Forest Research Inst., Zagreb (Yugoslavia). Dept. of Typology.
For primary bibliographic entry see Field 5B.
W90-02476

ABOUT THE HYDROGEOLOGICAL AND HYDROCHEMICAL BEHAVIOUR OF THE KARSTIC AREAS IN THE BASQUE COUNTRY (NORTHERN SPAIN, EUROPE).
Universidad del Pais Vasco, Bilbao (Spain). Dept. of Geodynamic.
I. Antiguedad, and A. Garcia de Cortazar.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 309-314. 3 fig, 2 tab, 2 ref.

Descriptors: *Water chemistry, *Geochemistry, *Geohydrology, *Karst hydrology, *Aquifers, *Karst, *Spain, Carbonate rocks, Factor analysis, Hydrologic maps, Rainfall, Correlation analysis.

The main hydrochemical and hydrodynamical features of the aquifers related to the different carbonate formations in Spain (jurassic, cretaceous and tertiary) have been summarized from a regional point of view. In general, waters show a mineralization of less than 450 mg/l. The relationship of different hydrochemical families to the diverse carbonate systems was demonstrated using a factorial analysis. However, meterological elements did not follow this pattern, and the fundamental recharge of the aquifer systems is from rain. A basic typology of karstic aquifers has been determined from the examination of hydrograms in some springs, taking into account their global response. It was found that local factors have the greatest influence on the development of karstic drainage. The results of studies carried out on diverse massifs of the region estimate the rate of karstic denudation (64 mm/1000 y with an average annual rainfall of 1600 mm; 125 mm/1000y with 2500mm/y rainfall) were in agreement with the previous estimates of the relationship between denudation and precipitation. The tracings showed variability in the flow velocities from 5 to 250 m/h. (See also W90-02444) (Mertz-PTT)
W90-02477

GENESIS, REGIME AND UTILIZATION OF KARST WATERS IN WEST CARPATHIANS MTS. (CZECHOSLOVAKIA).
Geologicky Ustav Dionyza Stura, Bratislava (Czechoslovakia).
E. Kullman, and V. Hanzel.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 315-319. 4 fig, 1 tab, 4 ref.

Descriptors: *Water resources development, *Karst hydrology, *Groundwater depletion, *Czechoslovakia, *Geohydrology, Groundwater management, Seasonal variation.

Karst waters of the West Carpathians are the most exploitable groundwaters in Czechoslovakia. Karst waters have formed in 80 hydrogeologic karst structures on areas totaling 10-100 square km with natural groundwater resources exceeding 30 cubic m/sec. Some of the structures formed are closed, isolated by impermeable sequences in their basement and on their periphery, so the inflow and outflow can be measured directly while others are open and cannot be measured directly. By measuring the long-term hydrological balance on selected hydrostructures, data on the precipitation-runoff relationship in single structures was obtained. The study of the karst water regime inside the hydrogeologic structures revealed substantial differences between the groundwater regime on the preferred paths and the regime of frontal leakage from the infiltration areas to the surface discharge areas in individual structures. A system was developed for using the karst spring water in combination with a seasonal utilization of the groundwater reserves of the spring structure. This approach is effective and economical (the increased effectiveness of the source is 50-100%). (See also W90-02444) (Mertz-PTT)
W90-02478

RELATIONSHIP BETWEEN KARST AND POROUS AQUIFERS ON THE CHALKIDIKI PENINSULA, GREECE.
Muenster Univ. (Germany, F.R.). Dept. of Geology and Paleontology.
E. P. Loehnert, and A. Papakonstantinou.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 321-326. 2 fig, 3 ref.

Descriptors: *Geochemistry, *Karst hydrology, *Aquifers, *Greece, *Isotope studies, *Geohydrology, Geologic mapping, Deuterium, Carbon dioxide, Oxygen isotopes, Boron, Tritium.

The relationship between karst and porous aquifers in a selected area of the western Chalkidiki Peninsula was investigated, using hydrochemical and isotopic parameters and taking into account the

prevailing hydraulic conditions in the two systems. The Katsikas karst was mapped as a positive geothermal anomaly which extends to the east under thin Neogene overburden. Karst waters were identifiable by deep-seated source components such as CO2 and the trace elements fluoride and boron, among others. The water is, however, of meteoric origin, as proven by oxygen-18 and deuterium whose variation may reflect slight altitude differences in the recharge area. The flowing water of a large artesian well appeared well mixed, but local recharge was suggested by elevated tritium values in pumped holes. Downstream in the porous aquifer system it was mainly the carbonate chemistry and the redox potential which varied. At deep confined levels of the multi-layered system, waters were encountered which were poor in tritium and fluoride and were sometimes depleted in oxygen-18 and deuterium. These pockets of water did not seem to have been flushed by karst waters. A quantification of the relationship between the two systems was hampered by the inhomogeneity of the porous system. Chloride, which occurred in all groundwaters at about the same level, is derived from precipitation, not seawater intrusion. (See also W90-02444) (Mertz-PTT)
W90-02479

ATTEMPT TO KARST CLASSIFICATION IN SPAIN BASED ON SYSTEM ANALYSIS.
F. J. Obarti, P. Garay, and I. Morell.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 328-336. 3 fig, 3 tab, 22 ref.

Descriptors: *Karst, *Karst hydrology, *Spain, *Hydrodynamics, *Hydrologic models, Classification, Systems analysis, Geologic mapping.

A classification of Spanish karst systems, based on geological features and hydrodynamic behavior observed in hydrographs of different system types, is presented. Systems were selected on the basis of their geographical and climatological representativity. The systems studied, selected from an extensive literature review augmented by additional data, were analyzed according to a model proposed by Mangin. The variables used for comparison purposes between selected systems were based on the relationship in each system between input and output (precipitation and discharge). This relation was evaluated using time-series analysis techniques in some cases and purely hydrologic methods in others, depending on the available data. The amplitude of hydrodynamic variation observed was very large and there was a strong dependence between ease of flow, degree of karst development, and karst evolution. In Spain, karst systems can be found with short time response to rain (memory effect and response time smaller than 10 days) and fast depletion (depletion coefficient larger than .01/day), corresponding to well-developed karst systems. These may coexist geographically with others distinguished by inertial behavior (memory effect: 1-2 days and depletion coefficient less than .01/day), representative of systems with impeded flow due to the low degree of karstification. However, the fastest responses and greatest degree of karst development were mainly in northern Spain where rainfall is greater than in lower latitudes. (See also W90-02444) (Mertz-PTT)
W90-02480

ANALYSIS OF TIME-DEPENDENT FACTORS OF BOSSEA KARSTIC SYSTEM (MARITIME ALPS--ITALY).
Politecnico di Torino (Italy). Dipt. di Georisorse e Territorio.
M. Civita, G. F. Olivero, and B. Vigna.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 339-344. 5 fig, 1 tab, 4 ref.

Descriptors: *Flow discharge, *Geohydrology, *Geochemistry, *Water chemistry, *Italy, *Karst hydrology, Dye releases, Water analysis, Chemical analysis, Caves.

Since 1982 the Bossea Cave in Italy has been equipped for continuous study of the flow discharge of a peculiar karstic system, where a limestone complex is supported and surrounded by basement rocks (quarzites and porphyroids). Dye tracer tests and hydrogeochemical analysis have aided understanding of the behavior of the system in different periods of the year. When no precipitation occurs in the recharge area, discharge is mainly supplied by a fractured quarzite aquiclude. Some chemical markers (sulfate and silica) have been identified in the system; they are related to two different recharge zones, one is made up of carbonate rocks, the other of crystalline basement rocks. Conductivity shows a good correlation with flow-rate and the highest conductivity values mark the high-water sections of the hydrograph. Only heavy rainfall causes a relative lowering of conductivity, especially when its effect is added to Spring snowmelt. (See also W90-02444) (Author's abstract)
W90-02481

HYDROGEOLOGICAL LIMITS OF THE FRIGIDO RIVER BASIN (APUANE ALPS).
Florence Univ. (Italy). Dipt. di Scienze della Terra.
L. Piccini, and G. Pranzini.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 345-350. 4 fig, 6 ref.

Descriptors: *Groundwater basins, *Karst hydrology, *River basins, *Hydrologic budget, *Italy, *Geohydrology, Geologic formations, Alpine regions, Dye releases.

Ground water circulation in the Apuane Alps in Italy is strongly conditioned by karstic features and very complex geological structures. It is therefore independent of the surface drainage in many cases. This study was undertaken to determine the actual extent of the Frigido River Basin, which, according to the data of the Hydrographic Office, should have a runoff coefficient equal to two. The limits of the Frigido Hydrogeological basin, estimated on the basis of geological structures, the discharges of springs, and the results of dye tracing tests in sinkholes and caves, were then compared with the hydrologic balance. There was a water surplus of 25%, which can be attributed to imprecision in the measurements of the Frigido discharges. (See also W90-02444) (Author's abstract)
W90-02482

ANHYDRITE-DOLOMITE FORMATION IN THE UPPER VALLEY OF THE RIVER SECCHIA: KARST HYDROGEOLOGY.
Modena Univ. (Italy). Ist. di Geologia.
A. Colombetti, and P. Fazzini.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 360-365. 1 fig, 5 ref.

Descriptors: *Geochemistry, *Karst hydrology, *Geohydrology, *Italy, Springs, Dye releases, Aquifer systems.

The karstic system of the Burano Formation in the upper valley of the River Secchia is of particular interest due to the presence, in the terminal part of the outcrop, of the chloride/sulfate Poiano overflow springs, which have a rate of flow ranging from 300 to 900 L/s. If the chemical composition of the Poiano spring waters is compared with that of other, mostly temporary, springs and also with that of surface water-courses, the hypothesis of two pathways of water circulation can be suggested. This is confirmed by a 100 m deep drilling, carried out at the bottom of the valley, which found local enrichments of halite in the gypsum layers. (See also W90-02444) (Author's abstract)
W90-02484

SEMI-COVERED KARST AQUIFERS IN THE OPHIOLITE BELT OF YUGOSLAV DINARIDES.
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
N. A. Kresic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 369-373. 3 fig, 5 ref.

Descriptors: *Geochemistry, *Karst hydrology, *Yugoslavia, *Aquifers, *Geohydrology, Chemical analysis, Geologic formations.

Mos karst aquifers in the Ophiolite Belt of Yugoslav Dinarides are developed in Triassic carbonates, mainly limestones, with thickness sometimes exceeding 1000 m. The limestones are intensively karstified and partly covered with less permeable rocks of the Diabase-Chert Formation and ultramafics, both of Jurassic age. The amount of discharged water indicates that all the big karstic springs draining these aquifers have a significant lack of catchment areas visible on the surface. This fact, along with the specific chemical composition of groundwaters (high content of silica and magnesium), has dictated complex hydrogeological research, which has been intensified in the last few years. (See also W90-02444) (Author's abstract)
W90-02485

HYDROGEOLOGY OF THE UPPER JURASSIC KARST AQUIFER WITHIN THE KRAKOW-WIELUN UPLAND (POLAND).
Silesian Univ., Katowice (Poland). Dept. of Earth Sciences.
A. Rozkowski, and A. Pacholewski.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 374-379. 7 ref.

Descriptors: *Karst hydrology, *Aquifer systems, *Poland, *Geohydrology, Springs, Water analysis.

The Upper Jurassic karst aquifer is located within the Drakow-Wielun Upland in Southern Poland. The Upper Jurassic limestones, with thickness up to 400 m, are covered in the majority of the areas by only Quarternary deposits. Karst phenomena--both surface and subterranean--are to a great extent typical for the area. Despite a variety of hydraulic properties, the Upper Jurassic limestone complex represents one hydraulically connected aquifer. Two separate aquifers appear only in the northern part of the region, where the carbonate complex consists of marl layers. The following hydraulic systems in the karst-fissured carbonate Upper Jurassic rocks in the Krakow-Wielun region exist: pores, fissures, open karst and filled karst forms. There are some 270 karst springs known in this area. The Upper Jurassic aquifer under the conditions of natural regime are fresh ones with slight mineralization of the HCO3-Ca type. CO2 and O2 dissolved in waters prove open circulation ways and oxygen environment. Concentrations of HCO3 (up to 307 mg/dm), SO4(-2) (up to 40 mg/dm), Cl(-) (up to 20 mg/dm), NO3(-) (up to 2.5 mg/dm), Ca(+2) (up to 100 mg/dm), Mg(+2) (up to 12 mg/dm), and total mineralization (up to 0.55 g/cubic dm) are typical of the waters. Higher concentrations can be observed at present due to water pollution. Industry is the main source of water pollution. (See also W90-02444) (Mertz-PTT)
W90-02486

GEOLOGY OF THE UPPER PALEOZOIC AQUIFER IN WESTERN BELGIUM.
Katholieke Univ. Leuven (Belgium). Inst. for Earth Sciences.
W. Loy, M. Dusar, and G. Verreet.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 380-385. 2 fig, 3 ref.

Descriptors: *Geohydrology, *Aquifer characteristics, *Belgium, *Karst hydrology, *Groundwater

management, Geologic mapping, Well data, Water demand.

In order to match the increasing water demand in the province of West-Flanders, Belgium, some production wells and a series of core-holes were used to define the limits of the upper Paleozoic aquifer. In this way the water withdrawal can be spread over a larger area, thus avoiding a too locally concentrated drawdown resulting in land subsidence (dolines). Since the Dinantian karstic aquifer formed the main target of the drilling campaign, a complete sequence of the Dinantian in the province of West-Flanders could be reconstructed totalling about 500 m in thickness and mostly composed of Tournaisian formations. Furthermore, new information is available on the extension of the Dionantian subcrop, faults with a +/-150 m throw, and the relation between structural patterns (lineations and uplifts) and the degree of karstification. The aquifer is mostly developed in the area of Spiere, in the subcrop zone of the Warchin and Pecq units. (See also W90-02444) (Author's abstract)
W90-02487

SEVERAL PRINCIPLE MECHANISMS OF KARSTIC SPRINGS IN SWITZERLAND RELATED TO PHYSICAL AND GEOLOGICAL CHARACTERISTICS OF THEIR CATCHMENT.
Neuchatel Univ. (Switzerland). Center of Hydrology.
Y. Lavanchy, I. Muller, F. Zwahlen, and U. Schotterer.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 386-393. 6 fig, 1 tab, 5 ref.

Descriptors: *Karst hydrology, *Switzerland, *Hydrodynamics, *Geohydrology, *Springs, Water chemistry, Chemical analysis, Mountains.

The long-term study of four karstic springs in Western Switzerland confirms the effect of the average altitude of the catchment on their hydrodynamic behavior and the physical and chemical characteristics of their waters. In addition, comparative analyses of flood events of two sources in the Jura mountains show that their hydrochemical response is particularly a function of conditions linked to the geological structure of the catchment. The average residence time of the spring waters varies from 1.5 to 5 years and indicates a generally well developed karstic flow system along the main geological structures. The great altitude differences and the resulting high flow velocities support this effect. The low and variable average age of the waters therefore reflects very sensitively the climatologically-influenced recharge variability and causes their vulnerability to human impacts. (See also W90-02444) (Author's abstract)
W90-02488

GEOLOGICAL FACTORS IN THE HYDROLOGY OF THE ORGAN CAVE PLATEAU, WEST VIRGINIA, USA.
Environmental Data, Cass, WV.
G. H. Deike.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 394-399. 2 fig, 5 ref.

Descriptors: *Karst hydrology, *West Virginia, *Geohydrology, Vadose water, Groundwater movement, Caves.

The 58 km long Organ Cave System in West Virginia drains a plateau of 9 square km. Vadose flow is in conduits trending down and component of the dip, and down the axis of a plunging syncline, directed by joints and faults of limited extent. Present and former phreatic development in the downstream part of the cave tends to parallel the strike in a zone up to 40 m below base level. Development takes place in several horizons in the limestone, beginning in certain cherty beds. Vadose incision is limited by dolomitic and clastic beds, notably by the shale at the base of the limestone. All runoff is underground, and there is little storage in the soil or the cave. A large water supply can only be found by drilling into a conduit in the phreatic zone, possible only in the limited area where the limestone dips below base level. (See also W90-02444) (Author's abstract)
W90-02489

HYDROGEOLOGIC STUDY OF A GYPSUM-DOLOMITE KARST AQUIFER IN SOUTHWESTERN OKLAHOMA AND ADJACENT PARTS OF TEXAS, U.S.A.
Geological Survey, Oklahoma City, OK.
D. L. Runkle, and K. S. Johnson.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 400-405. 4 fig, 7 ref.

Descriptors: *Geohydrology, *Artificial recharge, *Aquifer systems, *Oklahoma, *Texas, *Gypsum, *Karst hydrology, *Geohydrology, Geologic mapping, Dolomite, Groundwater management, Hydrological data collections.

Gypsum and dolomite beds of the Permian Blaine Formation constitute a major karst aquifer that provides irrigation water to a 4000 square km area in the Hollis Basin, a structural basin located in southwestern Oklahoma and adjacent parts of Texas. In addition to natural recharge, the Blaine aquifer is recharged artificially by diverting storm runoff into sinkholes and wells drilled into cavernous rocks. The data-collection activities of the current study, which began in 1985, include establishing water-level, water-quality, and water-use networks; inventorying irrigation and recharge wells and sinkholes; test drilling; measuring stream discharge; and estimating transmissivity of the Blaine aquifer. The data collected during the first two years of the study will be used to: map the structure and thickness of hydrogeologic units within and adjacent to the Blaine aquifer; determine the distribution of major, trace, and organic chemical constituents and radionuclides in the Blaine and associated aquifers; analyze the effects of extensive irrigation and artificial recharge on the quantity and quality of water in the Blaine and adjacent aquifers; and simulate the groundwater flow system with a numerical model. (See also W90-02444) (Author's abstract)
W90-02490

HYDROLOGIC CONNECTION BETWEEN SPRING WATER AND THE EVAPORITE OF THE LOWER ST. LOUIS LIMESTONE, KARST MITCHELL PLAIN OF SOUTHERN INDIANA.
Indiana Univ. at Bloomington. Dept. of Geology.
N. C. Krothe.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 406-416. 6 fig, 2 tab, 11 ref.

Descriptors: *Spring water, *Geohydrology, *Geochemistry, *Water chemistry, *Karst hydrology, *Indiana, *Water chemistry, *Isotope studies, Sulfur compounds, Gypsur., Groundwater movement, Geohydrology.

Water chemistry and sulfur isotope studies suggest two flow systems in the karst terrain of southern Indiana: (1) a shallow, fresh-water flow system exists, which is dominated by surface water entering the ground through fractures and solution features such as sinkholes; and (2) a deeper mineral water system that flows to depth (greater than 200 m) along the lower St. Louis gypsum. Sulfur isotope studies show that the freshwater has delta-34-S SO4 ranges from +10.61 to +12.80 ppt. Mineral water has delta-34-S SO4 ranges from +14.71 to +18.57 ppt. Isotope analysis of gypsum cores from the Lower St. Louis Limestone evaporite units shows delta-34-S SO4 values between +14.10 and +15.13 ppt in the study area. The waters with high SO4(-2) concentrations have delta-34-S SO4 values higher than the local gypsum deposits analyzed and contain H2S, suggesting a deeper flow system in which fractions by bacterial reduction of SO4(-2) is occurring. Waters with low SO4(-2) concentrations have sulfur-isotope variation values in the range of local fresh water, indicating a shallow flow system. (See also W90-02444) (Author's abstract)
W90-02491

IMPLICATIONS OF AQUIFER HYDRAULICS ON CONDUIT DEVELOPMENT IN KARST REGIONS.
Pennsylvania State Univ., University Park. Dept. of Geosciences.
G. Veni.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 417-420. 3 ref.

Descriptors: *Karst hydrology, *Conduits, *Confined aquifers, *Texas, Geohydrology, Free water, Groundwater management.

Conduit development in gravity-drained and artesian aquifers is characterized based on an investigation of over 200 caves in central Texas. Gravity drainage generally results in dendritic, tributary, conduit stream networks whose length far exceeds their vertical extent. High gradient flow is downdip, and low gradient flow moves along strike. Sedimentation does not occlude the conduits and headward vadose entrenchment is common. Conduits formed under artesian conditions are not as well understood, but often have conduit blockage by sedimentation near the water table, anastamotic flow networks, lower velocities and decreasing downstream conduit size. Understanding the form and development of these conduits can be a useful tool in the prediction, assessment and management of karst groundwater resources. (See also W90-02444) (Author's abstract)
W90-02492

INFLUENCE OF GEOLOGY AND KARST DEVELOPMENT ON THE FORMATION OF FRESHWATER LENSES ON SMALL LIMESTONE ISLANDS.
British Geological Survey, London (England).
J. D. Mather.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 423-428. 13 ref.

Descriptors: *Islands, *Atolls, *Karst hydrology, *Geohydrology, *Groundwater, *Groundwater reservoirs, Geologic control, Limestone, Saline groundwater.

The atolls of the Indian and Pacific Oceans and the small limestone islands of the Caribbean all contain fresh groundwater which forms lens-shaped bodies overlying deeper more saline groundwater. On a particular island, lens development is found to be principally controlled by the permeability of the limestone and in particular by the type of permeability. Unconsolidated sands of Holocene age where flow is intergranular are likely to provide the best prospects; more consolidated Pleistocene sands and lagonal deposits with youthful karst features and some fissure flow are likely to yield thinner lenses and older recrystallized limestones with mature karst features and fissure-controlled groundwater flow are likely to provide poor prospects. Examples of such geological control are illustrated by reference to groundwater conditions on Eleuthera (Bahamas), Providenciales (Turks and Caicos Islands), Barbuda (Leeward Islands) and Tarawa (Kiribati). (See also W90-02444) (Author's abstract)
W90-02493

HYDROGEOLOGIC CONDITIONS OF THE REGIONAL KARSTIC AQUIFER AND ASSOCIATED BRECCIA PIPES NEAR GRAND CANYON, ARIZONA, USA.
E.L. Montgomery, W. R. Victor, and J. W.

Harshbarger.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 429-434. 1 fig, 6 ref.

Descriptors: *Karst hydrology, *Arizona, *Aquifer characteristics, *Groundwater pollution, Uranium, Geohydrology, Grand Canyon.

The regional aquifer near Grand Canyon National Park, Arizona, comprises a sequence of karstic carbonate formations. Depth to the top of this sequence is more than 600 meters below land surface near the South Rim of the Grand Canyon; depth to groundwater in the aquifer is more than 760 meters. The aquifer is exposed in the lower wall of the Grand Canyon. Groundwater in the aquifer occurs in solution and fracture openings. The origin of more than 40 breccia pipe structures may be related to collapse in the solution openings. Several breccia pipes contain economic deposits of uranium ore. Concern regarding potential for groundwater contamination by mining operations at breccia pipes near the Grand Canyon has encouraged investigation of hydrogeologic conditions in the karstic aquifer. Uncommon problems were encountered during these investigations. Results indicate that unusual hydrogeologic conditions minimize potential impacts of mining operations on groundwater in the aquifer. (See also W90-02444) (Author's abstract)
W90-02494

KARST HYDROGEOLOGY OF SOUTHERN PART OF THE SIBERIAN PLATFORM.
Institut Zemnoi Kory, Irkutsk (USSR).
B. M. Shenkman.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 435-440. 2 fig, 1 ref.

Descriptors: *Karst hydrology, *USSR, *Geohydrology, Geomorphology, Siberia, Chemical composition.

The Angara/Lena artesian basin of the USSR is the largest karst province in the southern Siberian plateau. This karst consists of Cambrian and Ordovician carbonaceous rocks. Ordovician carbonaceous rocks on the Angara/Lena plateau occupy about 80,000 sq km and yield more than 200 cu m/s of groundwater resources. Cavern dolines are developed everywhere, but they are sometimes partly covered by terrigenous Ordovician sediments. The depth and character of karst water circulation, type of discharge, and the water's chemical composition and salinity are influenced by general geomorphology and the composition of the water-bearing rocks. The water-bearing complex is separated into relatively small aquifers by local erosional patterns. Groundwater flow is comparatively well-regulated within the year and long-term. It has a distinct 8-year cycle. The chemical composition of the water is hydrocarbonaceous with mineralization of 0.5 g/L. (See also W90-02444) (Mertz-PTT)
W90-02495

GROUND WATER FOR SMALL SCALE IRRIGATION IN MINIKARSTIC LIMESTONE TERRAIN IN SAURASHTRA AREA IN WESTERN INDIA.
Ground Water Inst., Poona (India).
S. D. Limaye.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 441-445. 1 fig.

Descriptors: *Groundwater irrigation, *Karst hydrology, *India, Limestone, Irrigation wells, Geohydrology.

Compared to other types of hard rocks such as granite, schist, gneiss and basalt (Deccan trap), limestone occupies a very small area in central and peninsular India. The soils overlying limestone terrain are usually poor and the crops require frequent irrigation. Whatever supply is available from dug wells is therefore useful for irrigating the crops on small farm plots owned by farmer families. In areas underlain by massive limestone the availability of ground water is poor. However, in the Saurashtra area in Western India, the development of minikarst in miliolitic limestone in the valleys and low lying areas, has a positive influence on ground water availability. This paper deals with the occurrence of ground water in the miliolitic and minikarstic limestone and with the exploration for suitable sites for dug wells for farmers. (See also W90-02444) (Author's abstract)
W90-02496

KARST HYDROGEOLOGY: INDIA.
Nagpur Univ. (India). Dept. of Geology.
K. S. Murty.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 446-450. 1 tab, 9 ref.

Descriptors: *Karst hydrology, *India, *Groundwater potential, Karst, Geohydrology, Limestone.

Among the 20 odd areas of groundwater potential in India, typical karstic rocks are present in the States of Madhya Pradesh, Andhra Pradesh, and borders of Maharashtra. The limestone of Raipur, Charmuria and Kajrahat belong to the Vindhyans, Cuddapahs and Bijawar formations of the Proterozoic age. The karstic areas of the Chatisgarh Basin and Baghelkhand region of Madhya Pradesh yield about 10.60 cubic m/hr. Exploratory drilling in Charmuria flaggy limestones has revealed saturated cavernous zones up to 60 m, though the discharge is poor. The effluence of the Indravati river in Bastar district is a good example of large potential in groundwater remaining locked up in these Indian karsts. However, the groundwater potential in most karstic areas of India is not high. (See also W90-02444) (Author's abstract)
W90-02497

KARST FEATURES OF THE ARABIAN PLATFORM AND THEIR INFLUENCE ON AQUIFERS.
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Research Inst.
A. E. Dabbagh, H. Hotzl, and J. G. Zotl.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 452-460. 4 fig, 1 tab, 8 ref.

Descriptors: *Karst hydrology, *Saudi Arabia, *Geohydrology, Geologic mapping, Aquifer systems, Groundwater recharge.

The Arabian Peninsula can be divided into two structural provinces. A western province, known as the Arabian Shield, is composed of Precambrian crystalline rocks, generally exposed but locally covered by Tertiary volcanic rocks. An eastern province, called the Arabian Platform, consists of a thick sedimentary sequence covering the igneous and metamorphic basement. The sedimentary sequence of the Arabian Platform consists of Paleozoic, Mesozoic, and Lower Cenozoic sedimentary rocks, well exposed in the great curved Interior Homocline and the Interior Platform. Some of the beds outcropping in the homocline and the platform are waterbearing and compose the most important fresh water resources of eastern Arabian Peninsula. One of the best known sequences of these aquifer beds is the Lower Tertiary Umm Er Radhuma Formation, which is the basis for the water supply of the large oases of Al Hasa and Al Qatif, as well as agricultural projects. The water balance of the Umm Er Radhuma Aquifer has been investigated by several hydrological experts. One of the open questions is still the present extent of recharge and supplement of the aquifer through karst solution features, which occur mainly in karstified regions of the Summan Plateau where these carbonates are exposed. (See also W90-02444) (Author's abstract)
W90-02498

KARST SYSTEM OF THE ALMIROS OF IRAKLION COASTAL SPRING (SYSTEME KARSTIQUE DE LA SOURCE LITTORAL ALMIROS D'IRAKLION).
B. F. Mijatovic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 461-473. 5 fig, 1 tab, 5 ref.

Descriptors: *Water resources development, *Karst hydrology, *Greece, *Geohydrology, *Saline water intrusion, *Springs, Reclaimed water, Coastal aquifers, Geologic mapping, Aquifer systems, Crete.

The great coastal spring Almiros of Iraklion, known since the Minoan period (2600 BC), is located on the shore 8 km west of Iraklion, the principal city of the Greek island of Crete. The water of the spring gushes from the foot of the karstic massif of Keri onto a small alluvial plain and flows toward the sea under the name of the River Almiros. Most of the Keri karst formation is contaminated by saline water. This was demonstrated by chemical investigations of the water in observation wells during low-water periods. The location of the flow-ways is determined by preferential dissolution caused by geologic accidents which define the main paths of subterranean water. At first sight, it would seem difficult to extract large quantities of water from this aquifer by exploitation drilling, even using large-diameter wells, given the character of the underground flows. However, underground collection galleries could be used to intercept the many complex channels. Besides the large flow thus assured, the water quality (in terms of chloride concentration) should prove good, the dynamic level of the karst water table being controlled by the above-sealevel position of the galleries, minimizing the possibility of seawater contamination of the fresh water. Before implementing a reclamation project, a detailed geohydrologic research program is required, including (A) the creation of a geohydrologic/structural map of the region; (B) a geophysical reconnaissance study of electrical resistivity; (C) drilling studies in the plain of Iraklion and along a cross section 3 to 4 km inland of the spring; (D) geophysical studies of electrical inductance, gamma rays, neutrons, temperature, and microcurrents; and (E) a statistical analysis of the principal parameters of flow, salinity, and water level. (See also W90-02444) (Shidler-PTT)
W90-02499

HYDROGEOLOGICAL INVESTIGATION OF THE KARST SUBMARINE SPRINGS ON THE MEDITERRANEAN COAST OF TURKEY, BY MEANS OF REMOTE SENSING TECHNIQUE.
Hacettepe Univ., Ankara (Turkey). Dept. of Hydrogeological Engineering.
G. Gunay, and H. Elkhatib.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 474-483. 8 fig, 2 tab, 16 ref.

Descriptors: *Karst hydrology, *Remote sensing, *Turkey, *Groundwater potential, Groundwater irrigation, Groundwater, Geologic mapping, Geohydrology, Hydrologic budget, Saline-freshwater interfaces.

The role and potential of remote sensing techniques were applied to the karst hydrogeology of Ovaclk area on the Mediterranean Coast of Turkey. In Ovaclk, where there is a great demand for irrigation water, the groundwater discharges from karst springs into the sea. Aerospace photographs, geological map and air photograph of the research site were analyzed and compared in order to follow and evaluate the different karstic features that are hydraulically connected with the Ovaclk submarine springs through subsurface conduits. Investigation of these karst springs also involves

other relevant studies to evaluate the characteristics of various lithological units, hydrological budget of the Ovaclk basin, freshwater-saltwater interface, main sources of groundwater and the quality of groundwater. (See also W90-02444) (Author's abstract)
W90-02500

HYDROLOGY OF THE ALEXANDRIA KARST REGION, EASTERN CAPE PROVINCE, SOUTH AFRICA.
M. E. Marker.
In: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 484-494. 9 fig.

Descriptors: *Karst hydrology, *South Africa, *Hydrologic maps, Catchment areas, Groundwater movement, Water quality.

The Alexandria karst area is located between Port Elizabeth and East London, South Africa. The Tertiary sandy micritic limestones provide an important aquifer. From information derived from the close network of farm boreholes, a piezometric surface map was constructed. Major springs emerge along the coast. Their karst water quality has been monitored for periods varying from 4 to 8 years in an attempt to derive the catchment area and the rate of the flow-through. A 2 to 3 month flow-through response period appears likely. This is similar to karst aquifers in the northeastern Transvaal. Unfortunately the period of record coincided with drought; therefore, the low correlation given by some of the data is attributed to the adverse climatic conditions. (See also W90-02444) (Author's abstract)
W90-02501

KARST HYDROGEOLOGICAL CONDITIONS AND ITS CHARACTERISTICS IN THE CENTRAL-SOUTH AREA OF SHANDONG PROVINCE.
The No. 801 Hydrogeology and Engineering Geology Party, Jinan, Shandong, China.
D. Xi.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 501-508. 3 fig.

Descriptors: *Karst hydrology, *China, *Groundwater movement, Recharge, Geohydrology.

The central-south area of Shandong Province, China covers about 67,000 square km. The Ordovician System is the main aquifer in the area and the karst water is abundant, though unevenly distributed, with good quality. In the low mountains and hilly land, karst groundwater is buried deep and water output is small. However, in urban areas such as Jinan and Zibo, karst water is abundant, supplying about 95% of the water. There are three kinds of main recharge sources for the karst water. Rainfall is the main recharge source, followed by surface water leakage, and replenishment of Quaternary pore-space water. Movement of karst water is interrupted by igneous bodies or veins that resist the water flow, aquiclude layers that also resist flow, and obstruction of karst water by faults. Karst water drainage occurs through springs, surface water and hidden springs. An understanding of the hydrogeological regularity and its characteristics of karst water has added to the knowledge of water filling in mining areas. It may provide a scientific basis for mine management and help solve the contradiction between water supply and mine drainage. (See also W90-02444) (Mertz-PTT)
W90-02502

HYDROGEOLOGIC ARGUMENTS ON THE FORMATION OF PALEO-KARST AND OIL POOL IN BURIED HILLS OF JIZHONG DEPRESSION IN NORTH CHINA.
Zhengding Inst. of Hydrogeology and Engineering Geology (China).
Y. Wang.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 510-517. 2 tab.

DkHcriptors: *Karst hydrology, *Carbonate rocks, *China, *Oil reservoirs, Karst, Geologic history.

The Jizhong depression, part of the Eastern Bohai Basin of China, is a faulted depression formed in the Mesozoic and Cenozoic Eras. Numerous drill-core observations have shown that there are extensively-developed dissolved karst features in the carbonate rock. Drilling data and the leakage volume of drill fluid have also revealed the scope of the spatial and temporal distribution of karst in the region, indicating its occurrence in the Middle and Upper Proterozoic, as well as in the Lower Paleozoic sequences, ranging from 1000-3000 m below the surface in depth and covering the whole region of study. Solution-extraction tests show that the carbonate rocks of different ages occurring at a depth of more than 1000 m have undergone strong desalination and are entering the final stage of carbonate leaching--evidence of karst development. The karstified pre-Tertiary marine carbonate rocks accumulated and concentrated late Tertiary oil and gas to form oil pools in these buried hills. Groundwater was the driving force of oil migration. Circulation patterns of the various water-bearing systems at this stage were mainly controlled by geostatic pressure. A great amount of free, bound, and crystalline water can be released. The amount of compressed water of the mudstones of the various terminal Pliocene strata has been calculated and isoline maps have been compiled. (See also W90-02444) (Mertz-PTT)
W90-02503

CHARACTERISTICS OF FISSURE KARST IN THE MIDDLE ORDOVICIAN LIMESTONE AND GROUNDWATER NATURAL RESOURCES IN THE WESTERN HILLS OF TAIYUNA, SHANXI PROVINCE.
Ministry of Geology and Mineral Resources, Beijing (China). Centre of Environmental Geology.
C. Ha, B. Tang, and R. Lu.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 518-526. 3 fig, 5 ref.

Descriptors: *Hydrologic budget, *Karst hydrology, *China, *Geohydrology, *Groundwater potential, Recharge, Geologic fractures, Carbonate rocks, Groundwater management.

The characteristics of fissure karst microscopically and macroscopically in the Middle Ordovician carbonate rocks in the Western Hills of Taiyuan, China and with the groundwater natural resources. Groundwater is a main source of water supply for Taiyuan City, about 50% of which is extracted from fissure karst groundwater in the Lower Palaeozoic carbonate rocks. The Western Hills of Taiyuan are located in Central Shanxi, on the eastern margin of the Luliang Mountains. Void space in the Cambrain and Ordovician limestones in the Western Hills comprises two parts: the one is openings formed under tectonic stresses, including fissures, joints, cracks and solution passages; while the other part is primary voids, such as pores of interlocking crystals and fabrics, intercrystal pores and secondary pores formed by weathering and leaking processes. According to the thin section analysis and the electron scanning identification, the micropores in the Cambrain and Ordovician carbonate rocks may be divided into three types: intercrystal pores, structural openings and caves. Macroscopically, the development of karst fissures and the distribution of groundwater are controlled by such factors as corroding processes, rock properties and structural conditions and so on. The karst groundwater resources in the Western Hills of Taiyuan are of certain amount in which the natural recharge of the Jinci Spring is 2.209 cubic meters per second; and of the Lancun Spring, 5.688 cubic meters per second. The withdrawal at present is nearly balanced with replenishment. The only way of increasing the withdrawal is to increase the groundwater recharge. (See also W90-02444) (Mertz-PTT)
W90-02504

KARST AND KARST GROUNDWATER IN SOUTH GUIZHOU, CHINA.
Guizhou Provincial Inst. of Geological Science, Guiyang (China).
D. Gao.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 532-542. 5 fig, 1 tab.

Descriptors: *Karst hydrology, *China, *Karst, Geohydrology, Groundwater potential, Geohydrology.

South Guizhou is one of the regions with the best developed karst in China. The general trend of karst development is that the previous karst landforms were strongly reformed and destroyed by the later karst actions caused by neotectonic uplift especially since the Middle Pleistocene. From the Miaolong Mountains in the north, a regional watershed of Guizhou, to the Hongshuihe River in the south, many kinds of karst combinations are developed regularly, and under each combination there are groundwaters buried at about the same depths, which are controlled by the nature of karst groundwater motion. Generally, the areas rich in karst groundwater with less buried depth, now the main areas for exploration, are developed in the reformed ancient karst landforms cut weakly by rivers and with better preserved karst groundwater-bearing conditions. 'The law of the best way' of karst channel development may be helpful in search of karst groundwater in the karst channels of these areas. (See also W90-02444) (Author's abstract)
W90-02505

STUDY OF DISU UNDERGROUND RIVER SYSTEM, DU'AN COUNTY, GUANGXI.
The Hydrogeology and Engineering Geology Party of Guangxi, China.
W. Chen.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 543-551. 6 fig.

Descriptors: *Karst hydrology, *Karst, *China, *Underground streams, *Geohydrology, River systems, Caves, Seismic properties, Remote sensing, Infrared imagery, Electromagnetic waves, Gravity studies, Radioactivity, Logging (Recording).

The water resources of the Disu underground river system, the largest in South China, were studied from 1959 to 1980. Characteristics and controlling factors of recharge, runoff, discharge, and hydraulic dynamics were investigated. The system has a total length of 241.1 km and a catchment area of 1004 square km and consists of 12 branches. The karst conduits in the upper reaches are simple, vein-structured in the middle reaches, and networked in the lower reaches. The system is characterized by a multi-level structure, flow velocity of 4-10 km/d, maximum discharge of 544.9 cubic m/sec, and an annual discharge of 1.2 times 10 to the 9th power cubic meters. The Disu underground river system is situated in midwestern Du'an County. Cave exploring, water tracing, drilling, hydrogeologic tests, infrared remote sensing, electric prospecting, well logging, seismic survey, very-low-frequency electromagnetism, radioactivity, and gravity prospecting have been employed to systematically study the system in the periods of 1959-1960, 1971-1973, 1976-1980, and up to the present. (See also W90-02444) (Mertz-PTT)
W90-02506

2G. Water In Soils

INFLUENCE OF MACROMOLECULES ON CHEMICAL TRANSPORT.
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5B.
W90-02144

VARIATION IN TENSION, WATER CONTENT, AND DRAINAGE RATE ALONG A 91-M TRANSECT.
New Mexico State Univ., Las Cruces. Dept. of Crop and Soil Sciences.
M. S. Nash, P. J. Wierenga, and A. Butler-Nance.
Soil Science SOSCAK, Vol. 148, No. 2, p 94-101, August 1989. 9 fig, 4 tab, 20 ref.

Descriptors: *Soil properties, *Soil water, *Drainage patterns, Percolation, Water tension, Statistical analysis, Chemical transport, Variation.

Recent studies on spatial variability determined means, variances, frequency distributions, and spatial correlation structures for a number of soil characteristics and soil types. In this study, the spatial distribution of soil water tension, water content, and percolation rates along a 91-m transect, sampled at 1-m intervals was determined. Coefficients of variation (CV) in soil-water tension were highest right after flooding, with values as high as 72%. As the soil dried out, CVs decreased to a range of 10 to 35% for all depths. Ranges of dependence for tension were between 13 and 35 m. Water contents showed the smallest variation near the surface (CVs less than 15%), and the highest in the subsoil (CVs of 30 to 45%) as a result of layering. Distances of dependence for water content were between 8 and 22 m. Drainage rates at 1.35 m below the soil surface varied widely, from 4.8 to 0.012 cm/d the first day after irrigation (mean 2.45 cm/d), and from 0.25 to 0.01 cm/d on Day 14 after irrigation (mean 0.15 cm/d). The extreme variability in drainage rates is expected to lead to large spatial variations in chemical transport in this and in similar soils. (Author's abstract)
W90-02153

MODELING SOIL SEAL AS A NONUNIFORM LAYER.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
Y. Mulalem, and S. Assouline.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2101-2108, October 1989. 15 fig, 2 tab, 29 ref.

Descriptors: *Infiltration, *Soil sealants, *Surface sealing, *Soil water, *Soil physical properties, *Soil compaction, *Soil mechanics, Model studies, Porosity, Water retention, Hydraulic conductivity, Crust properties, Seal thickness.

A quantitative conceptual model of soil sealing is proposed based on the assumption that the compaction of the upper soil layer by raindrops and the 'washed in' material result in a nonuniform change in bulk density, which can be approximated by an exponential function. The change in density causes in turn variation in soil properties, such as porosity, water retention, and hydraulic conductivity. Empirical functions are suggested to simulate the pattern by which these properties vary as dependent upon the density change. The model was calibrated using data of two experimental studies related to crust properties of three different soils: sandy loam, loam (loess), and clay loam. The model reproduced quite well the observed features of the experimental sealing characteristics. Seals developed in two different flow systems subjected to simulated rain were analyzed: (1) seal developed under saturated conditions over a shallow soil bed and (2) seal developed under unsaturated flow conditions. The proposed model highlights some soil parameters that are quite important and should be observed in soil sealing investigations. Based on the soil seal characteristics depicted, it is suggested that the thickness of the seal layer cannot be distinctly determined by eye, microscope or SEM observations because these means cannot distinguish between minor differences in soil structure which may result in significant differences in hydraulic properties. (Author's abstract)
W90-02188

NUMERICAL ANALYSIS OF SOLUTE TRANSPORT DURING TRANSIENT IRRIGATION: 1. THE EFFECT OF HYSTERESIS AND PROFILE HETEROGENEITY.
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
For primary bibliographic entry see Field 5B.
W90-02189

NUMERICAL ANALYSIS OF SOLUTE TRANSPORT DURING TRANSIENT IRRIGATION: 2. THE EFFECT OF IMMOBILE WATER.
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
For primary bibliographic entry see Field 5B.
W90-02190

ONE-DIMENSIONAL STEADY STATE INFILTRATION IN HETEROGENEOUS SOILS.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
T. C. Jim Yeh.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2149-2158, October 1989. 12 fig, 2 tab, 36 ref.

Descriptors: *Soil water, *Infiltration, *Infiltration rate, *Model studies, Soil hydrology, Hydraulic conductivity, Pressure head, Numerical simulations.

The effects of heterogeneity on one-dimensional, steady state infiltration are studied using numerical simulations where the soil hydrologic properties are assumed to be spatial stochastic processes. Analytical solutions to one-dimensional, steady state infiltration in heterogeneous soils are developed and applied to the stochastic random fields. The effects of spatial variability of parameters of an exponential unsaturated hydraulic conductivity model on the soil-water pressure profiles are examined. The amount of variation in pressure heads is found to vary with infiltration rates and mean pressure heads, while the cross-correlation between parameters is shown to have important influences on the value of the head variance. An inverse procedure is developed to determine the effective hydraulic conductivity parameters. The effective parameter is found to vary with mean pressures. Effective hydraulic conductivities and pressure head variances estimated from the numerical simulations were compared with those obtained from a spectral method developed previously. A unit mean gradient approach was used to estimate the effective unsaturated hydraulic conductivity, and the result shows that this approach is adequate for heterogeneous soils. (Author's abstract)
W90-02193

COMPARISON OF SOIL FREEZING CURVE AND SOIL WATER CURVE DATA FOR WINDSOR SANDY LOAM.
Cold Regions Research and Engineering Lab., Hanover, NH.
P. B. Black, and A. R. Tice.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2205-2210, October 1989. 6 fig, 3 tab, 16 ref. DA Project 4A161102AT24, Research in Snow, Ice and Frozen Ground, Task A.

Descriptors: *Frost, *Soil water, *Freezing, *Ground ice, Temperature, Soil moisture retention, Nuclear magnetic resonance, Sandy loam soil, Density.

Unfrozen water content as a function of temperature was measured in the laboratory using pulsed nuclear magnetic resonance (PNMR) for a Windsor sandy loam soil. The PNMR data were related to previously measured soil moisture retention data through the modified Clausius-Clapeyron equation, with suitable adjustment for surface tension. The transformed measured unfrozen water content data and the previously measured soil moisture retention data were expressed by a Brooks and Corey type of equation with the required set of regression parameters determined. It was found that a single set of parameters were sufficient to correctly express the behavior of these data when suitable constraints were imposed on the unfrozen water content data. It was shown that when the soils were strictly similar (i.e., when the same bulk density and history was used for the soil water curve and the soil freezing curve data), then a single relationship between moisture content and the phi variable, obtained from soil water curve and air-free soil freezing curve data, describe these moisture content data, demonstrating the validity of the procedure for granular, colloid-free soil. (Author's abstract)
W90-02199

CHANGES IN SOIL AND STREAM HYDROCHEMISTRY DURING PERIODS OF SPRING SNOWMELT AT A PRISTINE SITE IN MID-NORWAY.
Macaulay Land Use Research Inst., Aberdeen (Scotland).
For primary bibliographic entry see Field 5B.
W90-02263

2H. Lakes

TRACKING CALCIUM IN THE SAN JOAQUIN BASIN, CALIFORNIA: A STRONTIUM ISOTOPIC STUDY OF CARBONATE CEMENTS AT NORTH COLES LEVEE.
California Univ., Santa Barbara. Dept. of Geological Sciences.
J. L. Schultz, J. R. Boles, and G. R. Tilton.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1991-1999, Aug 1989. 8 fig, 2 tab, 38 ref.

Descriptors: *Geochemistry, *Water chemistry, *Limnology, *California, *Isotope studies, *Strontium radioisotopes, *Calcium, Carbonate cements, Crystallization, Interstitial water, Sediments, Mass transfer.

Strontium isotopes have been used as geochemical tracers of calcium to document pore water evolution and to track mass transfer at the North Coles Levee reservoir in the central San Joaquin basin, California. At North Coles Levee, the arkosic Miocene Stevens sandstone has been progressively cemented with a series of carbonate zones, with isotopically calculated crystallization temperatures ranging from approximately 25 to 95 C. This series of cement zones record a systematic decrease in the Sr87/Sr86 ratios of the pore water since burial, from sea water ratios of 0.7086 in early (<40 C) dolomite cements to near present-day pore water ratios of 0.7072 in the latest (>80 C) calcite cements. Strontium analyses of potential Ca-Sr sources in the central basin indicate that plagioclase, rather than calcium smectite or microfossil tests, is the only potential source with low enough strontium ratios to account for the isotopic compositions of the cements and the present pore water. This implies that plagioclase alteration is the dominant influence on the Sr-Ca pore water evolution at North Coles Levee. Our results indicate that calcium in the early calcites was derived from deeper in the basin, with mass transfer distances on the order of 1 km implied, and that calcium in later calcite cements was derived from plagioclase dissolving within the reservoir. (Author's abstract)
W90-01978

CARBOHYDRATE SPECIATION AND PY-MS MAPPING OF PEAT SAMPLES FROM A SUBTROPICAL OPEN MARSH ENVIRONMENT.
Technische Hogeschool Delft (Netherlands). Organic Geochemistry Unit.
M. E. C. Moers, J. J. Boon, J. W. de Leeuw, M. Baas, and P. A. Schenck.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 2011-2021, Aug 1989. 6 fig, 2 tab, 59 ref.

Descriptors: *Florida, *Wetlands, *Limnology, *Everglades, *Peat, *Marsh plants, *Carbohy-

drates, *Marshes, *Mass spectrometry, Marsh plants, Sugars, Pyrolysis-mass spectrometry.

Neutral carbohydrates were determined as alditol acetates in the hydrolysates of fractionated peat samples from different depths from Rookery Branch (Florida Everglades), and of a Mariscus rhizome. The fine grained samples showed a major contribution of microbial sugars indicated by comparatively low total carbohydrate yields together with high relative contributions of galactose, mannose, ribose, fucose, rhamnose, partially methylated aldoses, amino sugars, heptoses, tetroses, glycerol, allose and altrose. The coarse grained samples showed a major contribution of vascular plant sugars indicated by comparatively high total carbohydrate yields together with high relative contributions of glucose, xylose and arabinose. Analysis of the fractionated peat samples by Curie point pyrolysis-mass spectrometry and multivariate analysis of the pyrolysis data yielded two discriminant functions. Depth profiles for the first discriminant function show a relative accumulation of lignified vascular plant material with increasing depth in coarse and fine grained samples. The finest grained samples show most of the markers indicative of microbial activity and the presence of refractory fine grained matter and the least of the lignin markers. Plots of the second discriminant function versus depth reveal an initial increase in markers for modified lignin, indicating degradation. The deepest sample, however, again shows increased characteristics for intact vascular plant polysaccharides. The results from both wet chemical analysis and pyrolysis-mass spectrometric (Py-MS) suggest the presence of living and/or senescent rootlets at the deepest level in the peat. (Author's abstract)
W90-01979

SIMULATION-OPTIMIZATION ALGORITHM FOR RESERVOIR CAPACITY CALCULATION: THE EFFECT OF INFLOW DATA SET LENGTH.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W90-01982

EFFECT OF LIGHT AND TEMPERATURE ON DOC EXCRETION BY PHYTOPLANKTON.
Bar-Ilan Univ., Ramat-Gan (Israel). Dept. of Life Sciences.
I. Zlotnik, and Z. Dubinsky.
Limnology and Oceanography LIOCAH, Vol 34, No. 5, p 831-839, Jul 1989. 4 fig, 1 tab, 38 ref.

Descriptors: *Limnology, *Nutrients, *Cycling nutrients, *Phytoplankton, *Excretion, *Dissolved organic carbon, Light intensity, Temperature effects, Food chains.

The separate effects of light intensity (0-3,000 micromol quanta/sq m/sec) and temperature (5-45 degrees C) on excretion of dissolved organic carbon (DOC) by three phytoplankton species were examined under controlled laboratory conditions in axenic cultures. Ours is the first comparative study of the effects of a wide temperature and irradiance range on DOC excretion by different species of phytoplankton under identical conditions. Tight coupling was found between the rates of carbon fixation and of absolute DOC excretion over a wide range of irradiances (0-1,500 micromol quanta/sq m/sec) in all three species with excretion ranging from 1 to 55% of production. Chlorella vulgaris and Synechococcus sp. showed parallel temperature-dependent changes in photosynthesis and of absolute DOC excretion (5-45 degrees C); in Isochrysis galbana absolute excretion was temperature-independent, but photosynthesis was temperature-dependent. In all cases, increased excretion percentages were found under extreme irradiances and temperatures that depressed photosynthesis. In general, we suggest that high fluxes of DOC toward bacterial food chains may be expected only under conditions favorable for photosynthesis, although the percentage of DOC excretion is then low. (Author's abstract)
W90-01995

CYCLING OF ORGANIC CARBON IN THE PHOTIC ZONE OF A EUTROPHIC LAKE WITH SPECIAL REFERENCE TO THE HETEROTROPHIC BACTERIA.
Trondheim Univ. (Norway). Lab. of Biotechnology.
O. Vadstein, B. O. Harkjerr, A. Jensen, Y. Olsen, and H. Reinertsen.
Limnology and Oceanography LIOCAH, Vol. 34, No. 5, p 840-855, Jul 1989. 6 fig, 3 tab, 71 ref.

Descriptors: *Cycling nutrients, *Limnology, *Carbon cycle, *Eutrophic lakes, *Heterotrophic bacteria, Organic carbon, Food chains, Euphotic zone, Norway.

Cycling of organic carbon in the photic zone was investigated in a eutrophic Norwegian lake during the ice-free period. Special attention was paid to heterotrophic bacteria and the factors influencing their production and biomass development. The average proportions of the biomass of phytoplankton, zooplankton, and bacteria were 17:2:1 on a carbon basis. Phytoplankton primary production averaged 580 mg C/sq m/day, and 22% of the fixed carbon was exuded. Bacterial production, estimated by frequency of dividing cells, averaged 160 mg C/sq m/day and equaled 25% of the gross primary production on a seasonal basis. Increased bacterial activity was either correlated with increased exudation or followed a collapse in the phytoplankton community. Grazing was estimated to amount to 35-180% and 41-84% of the total losses of phytoplankton and bacteria. Cladocerans were the main grazers on phytoplankton, and heterotrophic flagellates were the main grazers on bacteria. Because of high death rates of zooplankton and cycling of carbon within the microbial loop, the available substrate for bacteria equaled the primary production on a seasonal basis. Exudates, egestion products from grazers, and dead zooplankton constituted two-thirds of the available substrate, and these sources were of equal magnitude. (Author's abstract)
W90-01996

GENERAL PATTERNS IN THE SEASONAL DEVELOPMENT OF CHLOROPHYLL A FOR TEMPERATE LAKES.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
C. T. Marshall, and R. H. Peters.
Limnology and Oceanography LIOCAH, Vol 34, No. 5, p 856-867, Jul 1989. 6 fig, 1 tab, 66 ref.

Descriptors: *Lakes, *Limnology, *Chlorophyll a, Temperate zone, Seasonal variation, Surveys.

The seasonal cycle of phytoplankton biomass in temperate lakes is often represented as spring and fall blooms with intervening biomass minima, but the generality of this pattern has never been critically evaluated. Chlorophyll a time series from 56 north-temperate lakes and reservoirs were collected and general patterns in the seasonal distribution of Chl a determined for oligotrophic and eutrophic lakes separately. The magnitude of temporal variation is greater in eutrophic lakes (mean Chl a concentration $>$ 12 mg/cu m) and is partitioned into discrete spring and fall blooms. Chlorophyll a concentrations in oligotrophic lakes (mean Chl a concentration $<$ 7mg/cu m) are low for the first 4 months of the year, then increase through April and May. Synchronous summer depressions and fall blooms are not evident for oligotrophic lakes overall. Mean Chl a concentration and mean annual air temperature were negatively correlated with the date of spring bloom. The date of spring bloom was not correlated with mean depth. (Author's abstract)
W90-01997

FLORIDA DIATOM ASSEMBLAGES AS INDICATORS OF TROPHIC STATE AND PH.
Florida Museum of Natural History, Gainesville.
T. J. Whitmore.
Limnology and Oceanography LIOCAH, Vol. 34, No. 5, p 882-895, Jul 1989. 4 fig, 6 tab, 28 ref.

Descriptors: *Limnology, *Eutrophication, *Florida, *Lakes, *Diatoms, *Model studies, *Trophic level, *Hydrogen ion concentration, Bioindicators, Nutrients, Regression analysis, Prediction.

Predictive models were developed that relate lake trophic state to diatom assemblages in surface sediments. These models can be used to assess quantitatively the historical impact of cultural activities on lake productivity. One set of models relates trophic state index (TSI) values to a new diatom index based on autecological nutrient categories. A second set uses nutrient categories in multiple regression equations to predict TSI. Both types of models explain approximately 80% of the variance in total phosphorus TSI and averaged TSI values. Diatom-pH transfer functions were also developed to assess the influence of eutrophication on lake pH. Because trophic state and pH are positively correlated in Florida lakes, statistical confounding might result when predictive models for pH and trophic state are calibrated. Long-term changes in pH might lead to errors when inferring historical TSI values, while changes in trophic state could similarly influence historical pH inferences. Partial correlations showed that two multiple regression models were statistically confounded by the nontarget variable, though predictive models based on diatom indices were free from such effects. (Author's abstract)
W90-01998

CHEMICAL COMPOSITION AND PHOSPHATE UPTAKE KINETICS OF LIMNETIC BACTERIAL COMMUNITIES CULTURED IN CHEMOSTATS UNDER PHOSPHORUS LIMITATION.
Trondheim Univ. (Norway). Lab. of Biotechnology.
O. Vadstein, and Y. Olsen.
Limnology and Oceanography LIOCAH, Vol 34, No. 5, p 939-946, Jul 1989. 4 fig, 5 tab, 40 ref.

Descriptors: *Limnology, *Cycling nutrients, *Phosphates, *Aquatic bacteria, *Limiting nutrients, Culturing techniques, Chemical composition, Absorption.

Natural bacterial communities were grown in chemostats diluted with filtered lake water manipulated to yield phosphorus limitation. The results suggested P limitation of the bacteria when the P:C and the surplus P:C ratios were between 17-120 and 2.7-100 microg P/mgC, respectively. These high values indicate that heterotrophic bacteria are net consumers of phosphate and that they sequester a considerably higher fraction of the particulate P in lakes than expected from their biomass in terms of carbon. Estimates of maximal uptake velocity and affinity for phosphate at low concentrations for the mixed bacterial communities were influenced by the degree of P limitation. A review of published data indicates that under P limitation bacteria are superior to phytoplankton in taking up phosphate at low concentrations, whereas their abilities are comparable at saturation. (Author's abstract)
W90-02000

USE OF THE THERMOTOLERANT AEROMONAS GROUP FOR THE TROPHIC STATE CLASSIFICATION OF FRESHWATERS.
Rhode Island Univ., Kingston. Dept. of Microbiology.
S. R. Rippey, and V. J. Cabelli.
Water Research WATRAG, Vol. 23, No. 9, p 1107-1114, 1989. 3 fig, 3 tab, 37 ref.

Descriptors: *Limnology, *Aquatic bacteria, *Indicator organisms, *Eutrophication, *Lake classification, *Monitoring, Correlation analysis, Secchi disks, Thermal stress, Phosphorus, Chlorophyll a, Aeromonas.

Data obtained from 68 lakes surveyed in the United States showed a highly significant correlation between the densities of a specific group of autochthonous, heterotrophic bacteria, thermotolerant aeromonads and the trophic state of fresh waters. This measurement provides a sensitive, accurate and facile descriptor of limnetic water quality and shows strong correlations with certain

other commonly employed physical, chemical and biological parameters used in this regard. The best correlations were obtained with Secchi depth (r = 0.70), total phosphorus (r = 0.72) and chlorophyll a (r = 0.67). An even stronger correlation was obtained with a trophic index derived from these three parameters (r = 0.84). Alternatively, total heterotrophic bacterial populations, as enumerated by epifluorescence microscopy, were very poorly correlated with all the individual trophic state measurements, and the indices derived from them. An analysis of correlations for trophic state parameters and indices used for this study indicated that the level of thermotolerant aeromonads was one of the most discriminating single parameters for defining trophic state. The economy of the measurement, coupled with its facility, makes it an exceptionally promising technique for assessing the degree and rate of fresh water eutrophication. (Author's abstract)
W90-02008

INTERSTITIAL WATER CONCENTRATIONS OF PHOSPHORUS, IRON AND MANGANESE IN A SHALLOW, EUTROPHIC SWEDISH LAKE-IMPLICATIONS FOR PHOSPHORUS CYCLING.
Uppsala Univ. (Sweden). Limnologiska Institutionen.
S. Lofgren, and B. Bostrom.
Water Research WATRAG, Vol. 23, No. 9, p 1115-1125, 1989. 9 fig, 2 tab, 46 ref.

Descriptors: *Limnology, *Water chemistry, *Sweden, *Iron, *Manganese, *Phosphates, *Eutrophic lakes, Cycling nutrients, Seasonal variation, Interstitial water, Sediment-water interfaces, Cores, Depth, Temperature, Chemical reduction, Microbial degradation, Oxidation, Lake Vallentunasjon.

Seasonal variation of ferrous iron, manganese and phosphate concentrations in the interstitial water (0-30 cm), ETS activities in the surface sediments (0-10 cm) and water quality properties were studied in 1983, in the polymictic, eutrophic Lake Vallentunasjon, Sweden. In addition, phosphorus release experiments using intact sediment cores were performed in the laboratory. Ferrous iron was generated to the interstitial water in two layers, namely in the surface sediments and at ca 10-30 cm down in the sediment. Manganese in a reduced form was mobilized in a single layer close to the sediment-water interface, while phosphate was generated at a sediment depth of 3-8 cm in shallow areas (2 m) and in deeper sediment layers (> 25 cm) at a water depth of 4 m. A mobilization of both ferrous iron and phosphate in the interstitial water, mainly during periods of high water temperature, and ETS activity in the surface sediments, suggests that microbial processes were involved in the liberation. Reduction of ferric iron-phosphate complexes could account for only a minor proportion of the phosphate mobilization in the interstitial water as demonstrated by the P/Fe molar ratios. In accordance, ferric iron formation, caused by ferrous iron diffusion from deeper sediment layers and oxidation at the sediment surface, could only partially retain the diffusive phosphate flux towards the sediment-water interface. The phosphorus retention capacity appears to be low in Lake Vallentunasjon sediments, even at high bottom water oxygen concentrations. (Author's abstract)
W90-02009

CHEMICAL RESPONSE FOLLOWING BASE APPLICATION TO LITTLE SIMON POND, NEW YORK STATE.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
For primary bibliographic entry see Field 5G.
W90-02105

GEOLOGY AND HYDROLOGY OF THE DEEP SUBSURFACE MICROBIOLOGY SAMPLING SITES AT THE SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Furman Univ., Greenville, SC. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02118

DISTRIBUTION OF AEROBIC BACTERIA, PROTOZOA, ALGAE, AND FUNGI IN DEEP SUBSURFACE SEDIMENTS.
Cornell Univ., Ithaca, NY. Dept. of Microbiology.
For primary bibliographic entry see Field 2F.
W90-02119

NUMBERS, DIVERSITY, AND MORPHOLOGICAL CHARACTERISTICS OF AEROBIC, CHEMOHETEROTROPHIC BACTERIA IN DEEP SUBSURFACE SEDIMENTS FROM A SITE IN SOUTH CAROLINA.
Florida State Univ., Tallahassee. Dept. of Biological Science.
For primary bibliographic entry see Field 2F.
W90-02120

LITHOTROPHIC AND HETEROTROPHIC BACTERIA IN DEEP SUBSURFACE SEDIMENTS AND THEIR RELATION TO SEDIMENT PROPERTIES.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2F.
W90-02121

AEROBIC METABOLIC POTENTIAL OF MICROBIAL POPULATIONS INDIGENOUS TO DEEP SUBSURFACE ENVIRONMENTS.
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 2F.
W90-02122

MICROBIAL ACTIVITIES IN DEEP SUBSURFACE ENVIRONMENTS.
Tennessee Univ., Knoxville. Inst. for Applied Microbiology.
For primary bibliographic entry see Field 2F.
W90-02123

AEROBIC AND ANAEROBIC MICROBIAL ACTIVITY IN DEEP SUBSURFACE SEDIMENTS FROM THE SAVANNAH RIVER PLANT.
Pennsylvania State Univ., University Park. Dept. of Agronomy.
For primary bibliographic entry see Field 2F.
W90-02124

DENITRIFICATION IN DEEP SUBSURFACE SEDIMENTS.
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
For primary bibliographic entry see Field 2F.
W90-02125

BIOGEOCHEMICAL PROCESSES AFFECTING ARSENIC SPECIES DISTRIBUTION IN A PERMANENTLY STRATIFIED LAKE.
Institut de Biogeochimie Marine, Montrouge (France).
For primary bibliographic entry see Field 5B.
W90-02142

FACTORS CONTROLLING THE REMOVAL OF SULFATE AND ACIDITY FROM THE WATERS OF AN ACIDIFIED LAKE.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W90-02160

MORPHOMETRIC STUDY OF LAGO PUYEHUE (40 DEG 30 MIN S; 72 DEG 32 MIN W), OSORNO, CHILE (ESTUDIO MORFOMETRICO DEL LAGO PUYEHUE, OSORNO, CHILE).
Instituto Profesional Osorno (Chile). Lab. de Limnologia.
T. G. Donoso, and J. D. Nunez.
Biota, Vol. 2, p 11-16, 1986. 3 fig, 1 tab, 12 ref. English summary.

Descriptors: *Limnology, *Lake Puyehue, *Glacial lakes, *Lake morphometry, *Chile, Maps.

A bathymetric chart was made of Lago Puyehue, Chile. Based on this chart, the morphometric parameters were calculated and the hypsographic curves of area and volume were made. The results show this lake to be of glaciar origin of the 28c type according to the Hutchinson classification. (Author's abstract)
W90-02162

COLONIZATION OF A SUBMERSED AQUATIC PLANT, EURASIAN WATER MILFOIL (MYRIOPHYLLUM SPICATUM), BY FUNGI UNDER CONTROLLED CONDITIONS.
Wisconsin Univ.-Madison. Dept. of Plant Pathology.
C. S. Smith, T. Chand, R. F. Harris, and J. H. Andrews.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2326-2332, September 1989. 4 fig, 2 tab, 39 ref. Army Corps of Engineers grant DACW39-86-K-0020.

Descriptors: *Submerged plants, *Limnology, *Aquatic fungi, Eurasian water milfoil, Aquatic plants.

A laboratory assay to assess colonization of a submersed aquatic plant, Eurasian water milfoil (Myriophyllum spicatum), by fungi was developed and used to evaluate the colonization potential of Colletotrichum gloeosporioides, Acremonium curvulum, Cladosporium herbarum, Aureobasidium pullulans, a Paecilomyces sp., and an unidentified sterile, septate fungus. Stem segments of plants were first immersed in suspensions of fungal propagules for 24 h and then washed to remove all but the tightly attached component of the population. Inoculation was followed by two growth cycles of 3 days each. At the start of each cycle, washed plants were transferred to a mineral salts medium to provide an opportunity for the attached fungal populations to grow. After each growth period, plants were again washed, and fungal populations in the medium (nonattached), loosely attached and tightly attached to the plant, and within the plant (endophytic) were assayed by dilution plating. The fungi differed in the extent to which they attached to water milfoil and in their ability to grow in association with it. There were relatively few significant differences among the tightly attached fungal populations after 24 h, but growth of the better colonizers led to a greater number of significant differences after 4 and 7 days. In addition, the better colonizers showed sustained regrowth of loosely and nonattached fungal propagules in the face of intermittent removal by washing. A milfoil pathogen, C. gloeosporioides, was the only endophytic colonizer; it was also among the best epiphytic colonizers but was not demonstrably better than A. curvulum, a fungus commonly found as an epiphyte on water milfoil. The yeastlike hyphomycete A. pullulans was the only fungus that consistently failed to establish an increasing population on the plant. (Author's abstract)
W90-02167

BREEDING-SEASON HABITAT USE BY STICKLEBACKS (PISCES: GASTEROSTEIDAE) AT ISLE VERTE, QUEBEC.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
F. G. Whoriskey, and G. J. FitzGerald.
Canadian Journal of Zoology CJZOAG, Vol. 67, No. 9, p 2126-2130, September 1989. 3 fig, 26 ref.

Descriptors: *Stickleback, *Aquatic habitats, *Fish behavior, *Fish migration, *Salt marshes, *Tidal marshes, Isle Verte, Quebec, Canada, St Lawrence Estuary.

Habitat use patterns of three species of sticklebacks were examined as they moved from the St. Lawrence estuary into tidal salt marsh pools to breed. All three species apparently avoided pools that dried out and settled more often in pools that retained their water. Habitat choice by immigrants was not influenced by either the presence of the

most aggressive species or by resident fish density. Movements of fish into the marsh and densities of fish in the pools peaked on the first days of the approximately 7-day flooding cycles, and declined thereafter. Thus, large numbers of fish moved away from these pools after initially settling in them, but the reason for this and the subsequent fate of the fish is unknown. (Author's abstract)
W90-02170

SHORT TERM NITROGEN DYNAMICS IN A SMALL BRAZILIAN WETLAND (LAGO INFERNAO, SAO PAULO).
Department of Scientific and Industrial Research, Taupo (New Zealand). Taupo Research Lab.
C. Howard-Williams, F. De Esteves, J. E. Santos, and M. T. Downes.
Journal of Tropical Ecology JTECEQ, Vol. 5, No. 3, p 323-335, August 1989. 5 fig, 2 tab, 26 ref.

Descriptors: *Limnology, *Cycling nutrients, *Wetlands, *Brazil, *Nitrogen cycle, Nitrogen fixation, Denitrification, Floating plants, Water hyacinth, Tropical regions, Ammonium, Oxygen, Diel cycle, Sediments, Oxbow lakes, Flood plains, Littoral zone.

A number of related processes of the nitrogen cycle in a Brazilian floodplain lake were studied to identify the major pools and pathways over a short time period. The study was centered on the littoral zone dominated by the floating plant Eichhornia azurea, which has a large epiphyte algal community of which heterocystous cyanobacteria were the major components. The water column was continuously undersaturated with oxygen although some elevated values (to 60% saturation) were recorded in the macrophyte beds in the afternoon. Marked diel temperature changes were documented. NH4-N dominated the dissolved N component in the water with maximal values (60 mg/cu m) at lowest oxygen concentrations early in the morning. Nitrogen fixation (acetylene reduction) of the epiphyte community showed marked diel changes with daily values of 5 mg N fixed/sq m/day (based on 3:1 acetylene:nitrogen ratio). Macrophyte NH4-N uptake rates (in situ incubations) were 93 mg N/sq m/day. The activities of nitrifying bacteria could not be detected with the nitrapyrin block on dark carbon dioxide fixation but denitrification (acetylene block technique) was recorded in the sediments when enhanced with NO3(-). The major pathways of aquatic nitrogen involved macrophyte uptake and sediment release of NH4-N. (Author's abstract)
W90-02207

LIFE HISTORY, ECOLOGY AND POPULATION STATUS OF MIGRATORY BULL TROUT (SALVELINUS CONFLUENTUS) IN THE FLATHEAD LAKE AND RIVER SYSTEM, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
J. J. Fraley, and B. B. Shepard.
Northwest Science NOSCAX, Vol. 63, No. 4, p 133-142, August 1989. 1 fig, 9 tab, 34 ref.

Descriptors: *Reservoirs, *River systems, *Lake fisheries, *Montana, *Flathead Lake, *Trout, Fish migration, Spawning, Growth, Aquatic habitats, Population dynamics, Fish management, Life cycles, Water temperature, Flathead River, British Columbia.

Life history, ecology, and population trends of migratory bull trout (Salvelinus confluentus) were investigated in the Flathead Lake and River system of northwest Montana and southeast British Columbia. These studies were conducted to obtain information to manage the species in light of threats posed by timber harvest, hydropower development, and a proposed coal mine. It was estimated that about half the adult bull trout in Flathead Lake embarked on a spawning migration from May through July, swimming 88-250 km to reach tributaries of the North and Middle Forks of the Flathead River. Bull trout entered the tributaries when water temperatures dropped below 12 C, and spawned from lake August through early October after water temperatures were below 9 C. They spawned in areas of tributaries with low gradient, loosely compacted gravel, groundwater influence, and cover. After spawning, females left the tributaries and returned to the lake sooner than males. Most spawners were 6 or 7 years old and they averaged 628 mm in length. Juveniles were found close to the substrate in streams in streams with summer maximum temperatures less than 15 C. Juveniles migrated out of the tributaries to the river systems from June through August, at age I (18%), II (49%), III (32%), and IV (1%). Population status was monitored through redd counts and estimates of juvenile abundance in natal tributaries. The population may be limited by quantity and quality of rearing and spawning habitat, and spawning escapement. Specific requirements for spawning and rearing habitat, and general sensitivity of each life stage, make the bull trout an excellent indicator of environmental disturbance. (Author's abstract)
W90-02214

HABITAT FEATURES AND TROUT ABUNDANCE RELATIVE TO GRADIENT IN SOME WYOMING STREAMS.
Forest Service, Fort Collins, CO. Wildlife and Fish Ecology Unit.
S. J. Kozel, W. A. Hubert, and M. G. Parsons.
Northwest Science NOSCAX, Vol. 63, No. 4, p 175-182, August 1989. 3 tab, 23 ref.

Descriptors: *Stream fisheries, *Trout, *Standing crops, *Aquatic habitats, *Wyoming, *Streams, Channel gradient, Fish management, Medicine Bow National Forest.

Channel gradient has been shown to have a negative relation to trout standing stocks, indicating that separation of stream channels into gradient classes may provide a better understanding of the relationships between habitat and trout abundance. The major objective was to determine if there are significant differences in habitat features and standing stocks of trout >100 mm between two classes of channel gradient, low (0.1-1.4% channel slope) and moderate (1.5-4.0%). Statistical relations between habitat features and trout standing stocks in each class of channel for unaltered streams on the Medicine Bow National Forest, Wyoming, were also determined. Low-gradient reaches were found to have deeper nearshore water depths, more undercut banks, and more trench pools than moderate-gradient reaches, while moderate-gradient reaches had more cobble substrate, dammed pools formed by woody debris, and plunge pools. The mean standing stock was 267 kg/ha in low-gradient reaches and 102 kg/ha in moderate-gradient reaches. Habitat features correlated with trout standing stocks differed between the two gradient classes. The results demonstrate that separation of stream segments into reaches of similar gradient are important in identifying features of trout habitat that are otherwise obscured by variation over a wider gradient range. (Author's abstract)
W90-02215

RESIDUAL INFLUENCE OF MACRONUTRIENT ENRICHMENT ON THE AQUATIC FOOD WEB OF AN OKEFENOKEE SWAMP ABANDONED BIRD ROOKERY.
Georgia Univ., Athens. Inst. of Ecology.
J. D. Oliver, and S. A. Schoenberg.
OIKOS OIKSAA, Vol. 55, No. 2, p 175-182, June 1989. 6 fig, 44 ref. NSF grants BSR 8114823 and BSR 8215587.

Descriptors: *Wetlands, *Okefenokee Swamp, *Georgia, *Limnology, *Swamps, *Birds, *Enrichment, *Food chains, Phosphorus, Nitrogen, Fertilization, Phytoplankton, Zooplankton, Fish, Guano, Sediments, Rookeries.

Evidence is presented for residual nutrient enrichment of diverse components of blackwater marsh, by a biotic component of the ecosystem itself. Thousands of nesting white ibis (Eudocimus albus) that foraged over a 20-km radius fertilized a rookery with guano within Okefenokee Swamp, Georgia. One to two years after the birds abandoned it, this marsh showed continued enrichment effects. Elevated available phosphorus in sediments, as measured by equilibrium phosphate concentration, contributed to enhanced biomass of phytoplankton in the overlying water column. Planktivorous fish were greater in biomass than at reference sites. Experimental phosphorus and nitrogen fertilization of enclosures at a reference site (at levels representing residual enrichment after birds had left) causes zooplankton biomass to increase significantly. These results demonstrate that this blackwater ecosystem was macronutrient limited, and manifested residual enrichment effects of wading birds on sediments, and a positive effect of sediments on phytoplankton. Results also suggest further indirect positive effects of birds on higher trophic levels (zooplankton and fish), via macronutrient transfers. (Author's abstract)
W90-02216

MODELLING LIGHT DISTRIBUTION WITHIN THE CANOPY OF THE MARSH GRASS SPARTINA ALTERNIFLORA AS A FUNCTION OF CANOPY BIOMASS AND SOLAR ANGLE.
South Carolina Univ., Columbia. Dept. of Biology.
J. T. Morris.
Agricultural and Forest Meteorology AFMEEB, Vol 46, No. 4, p 349-361, June 1989. 4 fig, 1 tab, 41 ref, append.

Descriptors: *Salt marshes, *Spartina, *Light penetration, *Water use efficiency, Model studies, Aquatic plants, Halophytes, Canopy.

A model of vertical light distribution in plant canopies as a function of canopy biomass and solar angle was derived and fitted to measured light profiles from salt marsh communities of the grass Spartina alterniflora. The model accounted for 73-95% of the variability in light profiles from different canopies at different times of day. In a single growing season, highly productive stands of S. alterniflora, capable of accumulating a canopy biomass of 1500 g/sq m or more, intercept 95% of photosynthetically active radiation according to both predictions and measurements. The sensitivity of leaf orientation to light interception was demonstrated by model calculations. Vertically oriented leaves at the top of the canopy absorb less light and, therefore, less heat than horizontal leaves, and it was hypothesized that leaf orientation in Spartina, a halophyte, optimally satisfies the constraints that light absorption and water-use efficiency are maximized while heat gain is minimized. (Author's abstract)
W90-02227

INFLUENCE OF LAKE TEMPERATURE ON GROWTH OF COREGONUS LAVARETUS L. LARVAE.
Konstanz Univ. (Germany, F.R.). Limnological Inst.
P. Rey, and R. Eckmann.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 2, p 181-190, August 1989. 2 fig, 3 tab, 17 ref.

Descriptors: *Temperature effects, *Limnology, *Lakes, *Seasonal variation, *Larval growth stage, Biological analysis, Lake Constance, Zooplankton, Coregonids.

Larval coregonids were sampled in Lake Constance in spring 1986. Length-frequency analysis revealed two growth phases: a period of slow growth lasting until the end of April, followed by a period of accelerated growth. The beginning of the second period coincided precisely with a drastic increase of surface water temperature and with a rise of zooplankton abundance. However, temperature is considered to be the trigger for onset of coregonid larval growth in Lake Constance. Otolith increments were not discernible prior to the beginning of thermal stratification, but thereafter daily growth rates could be calculated from otolith ring widths. Two groups of larvae could be distinguished: slowly growing specimens (low contrast rings of narrow width), and fast growing specimens (high contrast rings of increasing width). We suggest that first group comprised those larvae which were too weak to benefit from the improved conditions, and that an earlier onset of thermal

stratification would possibly reduce the number of larvae falling into this group. The second group would definitely benefit from earlier thermal stratification because early onset of growth would reduce both predation risk and competition and thus, improve their survival rate. These results support the concept of temperature influence on year-class strength of coregonids in Lake Constance. (Author's abstract)
W90-02231

DISTRIBUTION OF PHYLLOQUINONE (VITAMIN K1) IN A SMALL INLAND LAKE.
U. M. Cowgill.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 2, p 199-208, August 1989. 4 tab, 28 ref.

Descriptors: *Biodegradation, *Limnology, *Vitamins, *Lakes, Vitamin K, Phylloquinone, Nutrients.

Relatively little is known of the behavior of vitamin K1 (phylloquinone) in aquatic systems. Thus, the purpose of this study was to discover the distribution of phylloquinone in Linsley Pond, a kettle hole in North Branford, Connecticut. Over a period of three successive summers, samples were taken of aquatic macrophytes, plankton, water representing the entire water column, water-mud interface and mud from the littoral zone, as well as the deep water. Water samples, as well as the liquid portion of the mud-water interface samples, were examined for vitamin K1 in both the filtered and unfiltered state. The results showed that vitamin K1 was detectable only in aquatic macrophytes and plankton tows. It was not detectable in filtered water (0.22 micrometer millipore), filtered liquid of the mud-water interface samples or in the mud. It is hypothesized that phylloquinone present in dead plant material or in phytoplankton deposited in the mud or suspended in water is subjected to bacterial degradation and therefore is not detectable in nonliving substrates. (Author's abstract)
W90-02232

FACTORS AFFECTING THE SPATIAL AND TEMPORAL DISTRIBUTION OF PHOTOTROPHIC SULFUR BACTERIA.
Waterloo Univ. (Ontario). Dept. of Biology.
A. Mazumder, and M. D. Dickman.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 2, p 209-226, August 1989. 7 fig, 3 tab, 33 ref.

Descriptors: *Limnology, *Daphnia, *Seasonal variation, *Sulfur bacteria, *Zooplankton, *Meromictic lakes, Hydrogen sulfide, Bacteria.

Seasonal and vertical distribution of phototrophic sulfur bacteria and their relationships with changes in physico-chemical parameters, abundance of dominant zooplankton species, and in situ grazing by Daphnia, were studied in meromictic Crawford Lake, Ontario. Purple and green sulfur bacteria were common, with purple forms being dominate. These bacteria formed a 2 m thick layer whose upper boundary was set by H2S concentration and lower boundary was set by light intensity. The peak concentration on any date was at a depth where light intensity was optimum and H2S concentration was maximum. The position of the bacterial layer shifted up following summer algal blooms and shifted down following oxygen intrusion into the lower mixolimnion and chemocline following overturns. Temporal changes in the concentration of bacteria were related to abundance of Daphnia near the bacterial layer, suggesting that Daphnia grazing may control bacterial biomass. That Daphnia consume phototrophic bacteria was supported by in situ grazing measurements, aggregation of Daphnia immediately above the bacterial layer, higher abundance of pink Daphnia in the deeper water, and spectrophotometric analysis of crushed Daphnia. Daphnia at the bacterial layer consumed over 1.8%/hour (seasonal average) of the phototrophic bacterial biomass, and substantially more on several occasions in the summer. (Author's abstract)
W90-02233

LAKE TYPOLOGY AND INDICATOR ORGANISMS IN APPLICATION TO THE PROFUNDAL CHIRONOMID FAUNA OF STARNBERGER SEE (DIPTERA, CHIRONOMIDAE).
Institut fuer Tierwissenschaften, Freising (Germany, F.R.).
R. Gerstmeier.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 2, p 227-234, August 1989. 4 fig, 26 ref.

Descriptors: *Lake classification, *Limnology, *Midges, *Species composition, *Bioindicators, *Mountain lakes, Mesotrophic lakes.

The profundal chironomids have been used as indicator organisms for trophic characterization of Starnberger See, a northern prealpine lake. Results from the practical application Saether's trophic classification and Wiederholm's Benthic Quality Index are presented and also Brundin's lake typology is discussed. According to Brundin's subdivisions, The typical chironomid associations in the profundal zone of Starnberger See should consist of representatives of the Stictochironomus rosenschoeldi and Sergentia coracina groups. While Sergentia coracina represented the second most abundant genus in the profundal zone of Starnberger See, Stictochironomus was entirely absent. On the basis of the distinct dominance of the genus Micropsectra, Starnberger See should be designated, sensu Thienemann, as a Tanytarsus lake--which would contradict the preceding statement. In general, however, the very widely interpretable term Tanytarsus lake should no longer be employed, because the species of this genus have very different ecological requirements. This apparent discrepancy was explainable by taking into account the oxygen conditions. Because oxygen was not a limiting factor in Starnberger See, cold-stenothermic species, such as Micropsectra contracta could maintain thriving populations in the profundal zone. Therefore, Starnberger See could be designated a mesotrophic lake, with Micropsectra contracta as the leading form, and M. coracina, Sergentia coracina, Tanytarsus bathophilus and T. lugens as further predominating species. (Mertz-PTT)
W90-02234

OPTICAL PROPERTIES AND THEIR RELATION TO LIGHT UTILIZATION BY PHYTOPLANKTON IN THE STRATIFIED PERIOD IN THE NORTH BASIN OF LAKE BIWA.
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
R. Tsuda, and M. Nakanishi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 116, No. 2, p 235-244, August 1989. 5 fig, 3 tab, 15 ref.

Descriptors: *Limnology, *Optical properties, *Light penetration, *Lakes, Particulate matter, Japan, Phytoplankton, Lake Biwa, Photosynthesis.

The effect of composition of suspended particles regarding the optical properties of the waters on the attenuation of photosynthetically available radiation was investigated at an offshore station in the north basin of Lake Biwa in June and September 1982. Despite high concentration of chlorophyll-a and particulate carbon, inorganic particles mainly contributed to the attenuation of photosynthetically available radiation in September. On the other hand, detrital organic particles, affecting the attenuation of photosynthetically available radiation, made up the major portion of suspended particles in June. Light utilization related to photosynthetically available radiation due to algal cells was estimated with light utilization efficiency. Values of light utilization efficiency in September increased with depth in the range of 0.4% at 0.5 m depth to 2.5% at 10 m depth, and light utilization efficiency in June was lower at any depth than that in September. This lower value was due to the optical properties of suspended particle composition. (Author's abstract)
W90-02235

ACCUMULATION AND DIAGENESIS OF CHLORINATED HYDROCARBONS IN LACUSTRINE SEDIMENTS.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
For primary bibliographic entry see Field 5B.
W90-02246

MORPHOLOGY OF CALCITE CRYSTALS IN HARDWATER LAKES.
Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Elektronenphysik.
H. Raidt, and R. Koschel.
Limnologica LMNOA8, Vol. 19, No. 2, p 3-12, 1988. 7 fig 1 tab, 24 ref.

Descriptors: *Crystal growth, *Calcite, *Physical properties, *Lakes, Hardness, Chemical properties, Electron microscopy, Eutrophic lakes, Oligotrophic lakes.

The morphology of pelagic calcite crystals from a broad spectrum of different types of hardwater lakes was investigated by using scanning electron microscopy. An atlas of typical crystal habits is given. Starting with the equilibrium-polyhedron. Two lines of development of crystal forms was assumed. At relatively low supersaturations and high adsorption rates at the edges and corners of crystal forms rough surfaces appear. The rough areas are spread over the whole surface and calcite crystals are formed without smooth faces. This line was primarily observed in eutrophic lakes and in deeper layers of oligotrophic to mesotrophic lakes. The other line was dendritic growth. Dendritic growth of calcite during high supersaturations was obtained in oligotrophic to weakly eutrophic lakes, especially in epilimnic layers during the late spring and summer period. With increased supersaturation more complicated dendrites were formed. The transformation of complicated calcite crystal forms proceeds both in mixed and nonmixed layers of oligotrophic to eutrophic lakes. An accumulation of these forms took place primarily in nonmixed layers in the deep parts of the hypolimnion. (Mertz-PTT)
W90-02248

ALGOLOGICAL OBSERVATIONS IN WATERS OF BIOSPHERE RESERVATION 'STECKBY-LODDERITZER FORST' (G.D.R.) (ALGOLOGISCHE BEOBACHTUNGEN IN GEWASSERN DES BIOSPHARENRESERVATES 'STECKBY-LODDERITZER FORST' (DDR)).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
L. Krienitz.
Limnologica LMNOA8, Vol. 19, No. 2, p 61-81, 1988. 21 fig, 3 tab, 52 ref. English summary.

Descriptors: *Limnology, *Algae, *Cyanophyta, *East Germany, *Chlorophyta, *Euglenophyta, Conjungatophyceae, Shallow water, Elbe River, Rivers.

Light microscopical observations on algal flora of shallow waters and dead branches of the river Elbe in the biosphere reservation Steckby-Lodderitzer Forst (German Democratic Republic) are presented. The observed algae belong to the Cyanophyceae, Chlorophyceae, Conjungatophyceae and Euglenophyceae. Noteworthy observations were the mass developments of Anabaenopsis elenkinii Mill., Chlamydomonas petasus Ettl., Scenedesmus grahneisii (Heynig) Fott, Euglena hemichromata Skuja and Lepocinclis teres (Schmitz) France. The following taxa are new for the territory of the German Democratic Republic: Anabaena compacta (Nyg.) Hickel, Lobomonas ampla Pasch. var. mammilata (Swar.) Kors., Sphaerellopsis cylindrica Skuja, Gloeotila contorta Chodat, Cosmarium pyhmaeum Arch. var. apertum Skuja and Mougeotia cf. talyscensis (Woron.) Czurda. The new ulotrichacean species Geminella verrucosa was described. (Mertz-PTT)
W90-02249

INVESTIGATIONS OF THE SUBMERGED VEGETATION IN SCANDINAVIAN LAKES WITH SPECIAL CONSIDERATION OF THE VEGETATION OF ISOETIDS (TAUCHUNTERSUCHUNGEN DER SUBMERSEN VEGETATION IN SKANDINAVIASCHEN SEEN UNTER

BERUCKSICHTIGUNG DER ISOETIDEN-VEGETATION).
M. Voge.
Limnologica LMNOA8, Vol. 19, No. 2, p 89-107, 1988. 10 fig, 11 tab, 36 ref. English summary.

Descriptors: *Aquatic plants, *Scandinavia, *Macrophytes, *Acid rain effects, *Limnology, *Lakes, *Plant populations, Chemical properties, Isoetids, Lobelia, Myriophyllum, Elodea, Hydrogen ion concentration, Alkalinity, Hardness, Conductivity, Ecological distribution.

In 40 scandinavian lakes submerged vegetation was investigated, species inventory and releves are given. Lakes were characterized by pH, alkalinity, total hardness and conductivity; afterwards they were attached to pH-fields. Releves from southern Norway were related to Isoetok-Lobelietum (W. Koch 1926) Tx. 1937 emend. mostly. All single releves were evaluated. Vegetation of isoetids was divided into two types: Littorella-Lobelia (LitLoT) and Isoetes-Lobelia-Type (IloT); there were three variants of the last type: typical, Isoetes lacustris-variants and Lobelia-variants. In middle and northern Norway, vegetation of elodeids was found as well: Myriophyllum alterniflorum makes four vegetation types. The authors tried to define a typical formation of IloT:typV and to characterize it. Effects of acid rain on vegetation of isoetids (change of flora, intensive development of algae) in southern Norway and those of eutrophication are described. Botanical eutrophy-index was calculated for all types and variants in respective pH-fields. Endangering of vegetation of isoetids is discussed. (Author's abstract)
W90-02250

ECOLOGICAL AMPLITUDE AND BIOINDICATIVE VALUE OF COMMON SWAMP ASSOCIATIONS OF NORTH-EASTERN POLAND (OKOLOGISCHE AMPLITUDE UND ZEIGERWERT DER HAUFIGEREN ROHRICHTGESELLSCHAFTEN IM NORDOSTLICHEN TEIL POLENS).
Warsaw Univ. (Poland). Dept .of Phytogeography.
S. Klosowski.
Limnologica LMNOA8, Vol. 19, No. 2, p 109-125, 1988. 6 fig, 3 tab, 93 ref.

Descriptors: *Limnology, *Aquatic plants, *Marshes, *Aquatic habitats, *Macrophytes, *Wetlands, *Poland, *Swamps, Scirpetum, Eleocharitetum, Typhetum, Cladietum, Thelypteridi-Phragmitetum, Caricetum, Chemical analysis, Physical properties, Chemical properties.

A comparative analysis of habitats of eight swamp associations, common in north-eastern Poland, such as Scirpetum lacustris, Eleocharitetum palustris, Typhetum angustifoliae, Typhetum latifoliae, Cladietum marisci, Thelypteridi-Phragmitetum, Caricetum actiformis and Caricetum elatae was carried out. In representative phytocoenoses of the species associations phytosociological releves were recorded, and the physicochemical composition of water and substrate were analyzed. More than 200 phytocoenoses were studied for each association. The analysis of the data indicated that the associations studied differed considerably in respect to habitat requirements in relation to both water and substrate characteristics. Waters inhabited by phytocoenoses of eight described associations could be divided into five types. Substrates of the investigated associations comprise six types. On the grounds of comparison of phytosociological data, was well as physical and chemical properties of water and substrate in the phytocoenoses, it was found that phytosociological differentiation of associations classified according to floristic dominance was confirmed in the habitat differentiation. Individual associations or their groups, because they showed distinct habitat individuality, had some indicative value. (Mertz-PTT)
W90-02251

VARIATION IN THE MACROPHYTIC BIOMASS BETWEEN A LENTIC AND A LOTIC SYSTEM IN RELATION TO ABIOTIC FACTORS.
Bhagalpur Univ. (India). Dept. of Botany.
L. C. Saha, and B. Pandit.
Limnologica LMNOA8, Vol. 19, No. 2, p 127-130, 1988. 1 fig, 3 tab, 16 ref.

Descriptors: *India, *Ponds, *Aquatic plants, *Macrophytes, *Rivers, *Limnology, *Biomass, Physical properties, Chemical properties, Water properties, Ecological distribution.

Water samples from ponds selected because of their squarish and rectangular shape and riverine sites on the river Ganga (India) were analyzed at monthly intervals from January 1984 to December 1985. For the analysis of the macrophytic biomass, five samples were taken at random using a quadrat of 1 square m. Plants were removed along with the soil. Material was dried and the annual increment was calculated. The abiotic conditions of the water bodies present during winter months were more suitable for growth and reproduction of macrophytic vegetation. It is also clear from the statistical result that there was always a negative correlation between water temperature and the macrophytic biomass. Comparative composition and macrophytic biomass of lentic bodies and a lotic system have been described in relation to certain abiotic factors of water and bottom soil. A marked variation was obtained in the composition of the macrophytic community and the values of macrophytic biomass between pond and riverine system. The pond system showed 17.38 times higher biomass values than the riverine sites. Various physicochemical properties of water (temperature, turbidity, O2, phosphate, nitrate-nigrogen, potassium, etc.) and of the bottom soil (pH, phosphate) significantly influenced the biomass values in different ways at different sites. (Mertz-PTT)
W90-02252

BACTERIOLOGICAL PARAMETERS AND BIOMONITORING OF WATERS: A COMPARISON OF SITES (BAKTERIOLOGISCHE PARAMETER UND BIOMONITORING VON GEWASSERN: EIN STANDORTVERGLEICH).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 5A.
W90-02253

MICROBIAL DECOMPOSITION OF PLANT DETRITUS IN LAKES (UNTERSUCHUNGEN ZUM MIKROBIELLEN ABBAU VON PFLANZLICHEM DETRITUS IN SEEN).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
P. Casper, C. Babenzien, and G. Proft.
Limnologica LMNOA8, Vol. 19, No. 2, p 147-159, 1988. 12 fig, 4 tab, 48 ref. English summary.

Descriptors: *Limnology, *Detritus, *Decomposition, *Decomposing organic matter, *Bacterial analysis, Aerobic conditions, Anaerobic conditions, Carbon, Phosphates, Chemical analysis, Macrophytes, Vegetation, Nutrients.

The decomposition of two types of plant litter (Fagus sylvatica and Potamogeton lucens) was examined under aerobic and anaerobic conditions in laboratory experiments during 120 days. Measurements of bacterial numbers and activities of dissolved carbon and ortho-phosphate were carried out. Decomposition of both plant materials followed three different patterns with time: (1) rapid increase to a maximum after 10 days; (2) decrease during days 10-35; and (3) a plateau, which was maintained. Different results were obtained between aerobic and anaerobic conditions. Especially the rate of 14C-acetate-incorporation differed. The rate was characterized under anaerobic conditions by a peak after about 60 days. Decomposition of an aquatic macrophyte (Potamogeton lucens) compared to terrestrial plant litter (Fagus sylvatica) showed that bacterial numbers and bacterial activities reached maxima some days earlier (P.lucens after 3 days; F. sylvatica after 10 days). F. sylvatica was decomposed more slowly than P. lucens. (Author's abstract)
W90-02254

ENCLOSURE EXPERIMENTS IN FOOD-WEB MANIPULATION: FIRST STEP--DIVIDING THE EXPERIMENTAL LAKE.
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
P. Kasprizak, R. Koschel, U. Steiner, and K. Metzdorf.
Limnologica LMNOA8, Vol. 19, No. 2, p 161-165, 1988. 4 fig, 2 tab, 23 ref.

Descriptors: *Limnology, *Lake restoration, *Acidic water, *Aquatic populations, *Bogs, *Lakes, *Food chains, Biological analysis, Algae, Crustaceans, Chlorella, Chrysophytta, Eudiaptomus, Diaphanosoma, Corixidae, Species diversity.

Lake Grosse Fuchskuhle is a naturally acidic bog lake which was selected for experiments in food-web manipulation because of its special suitability. The relatively simple structure of the community of the pelagic zone consisted of a small number of algal species (Chlorella spec., Dinobryon pediforme) and the crustaceans Eudiaptomus gracilis and Diaphanosoma brachyurum. Fish were rare, but numerous waterbugs (Corixidae) and phantom midges (Chaoborus) inhabited the lake. To compare experiments, the water was subdivided into two basins of about 25,000 cubic m using a large plastic curtain. Considerations for the use in experiments of extreme biotopes with low pH to manipulate the food-web are included. In these lakes the typical trophic levels existed connected by recycling and exchange processes. Therefore, this extreme biotope was basically comparable to ecosystems with high diversity. However, the low number of acid tolerating species restricted the possible reactions in response to manipulations of the food-web. Therefore the effects of manipulations can be observed more clearly in acidic lakes than in circumneutral lakes with greater species diversity. (Mertz-PTT)
W90-02255

SAMPLE SIZE--PARTICLE SIZE--ERROR OF SAMPLING: CONTRIBUTION TO THE ANALYSIS OF PARTICULATE BIOMASS, (PROBENGROSSE--PARTIKELGROSSEE-FEHLERGROSSE: ZUR ANALYSE PARTIKULAR GEBUNDENER WASSERINHALTSSTOFFE).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 7B.
W90-02256

PROTOCOL FOR DETERMINING LAKE ACIDIFICATION PATHWAYS.
Environmental and Social Systems Analysts Ltd., Vancouver (British Columbia).
For primary bibliographic entry see Field 5B.
W90-02260

SIMPLE DOSE-EFFECT MODEL OF LAKE ACIDITY IN QUEBEC (CANADA).
Quebec Ministere de l'Environnement, Sainte-Foy. Direction de la Qualite du Milieu Aquatique.
For primary bibliographic entry see Field 5B.
W90-02261

DISSOLVED AND PARTICULATE TRACE METALS IN A WETLAND OF INTERNATIONAL IMPORTANCE: LAKE MIKRI PRESPA, GREECE.
Athens Univ. (Greece). Inst. of Inorganic and Analytical Chemistry.
For primary bibliographic entry see Field 5B.
W90-02262

MODELING CL CONCENTRATIONS IN CAYUGA LAKE, U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
For primary bibliographic entry see Field 5B.
W90-02264

ZOOPLANKTON COMMUNITIES AND ACIDIFICATION PROCESSES (A REVIEW).
Uppsala Univ. (Sweden). Limnologiska Institutionen.
For primary bibliographic entry see Field 5C.
W90-02266

INFLUENCE OF HYDROLOGICAL UNRELIABILITY ON WATER SUPPLY FROM RESERVOIRS (DER EINFLUSS DER HYDROLOGISCHEN UNSICHERHEIT AUF DIE VERSORGUNG DURCH WASSERKRAFTSPEICHER).
Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Wasserwessen.
For primary bibliographic entry see Field 6D.
W90-02272

LABELING OF ALGAE AND INORGANIC SEDIMENTS WITH NEUTRON-ACTIVATABLE INDICATOR ELEMENTS AND FLUORESCENCE DYES (MARKIERUNG VON ALGEN UND ANORGANISCHEN SEDIMENTEN MIT NEUTRONENAKTIVIERBAREN INDIKATOR-ELEMENTEN UND MIT FLUORESZENZ-FARBSTOFFEN).
Hanover Univ. (Germany, F.R.). Fachbereich Biologie.
For primary bibliographic entry see Field 7B.
W90-02277

TAMING THE FLOOD: A HISTORY AND NATURAL HISTORY OF RIVERS AND WETLANDS.
Severn-Trent Water Authority, Birmingham (England).
For primary bibliographic entry see Field 6G.
W90-02288

INFLUENCE OF RESERVOIR ON EARTHQUAKES IN KARST AREA--GRANCAREVO DAM SITE.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
For primary bibliographic entry see Field 6G.
W90-02459

2I. Water In Plants

ECOLOGY OF UNDERSTORY KELP ENVIRONMENTS: I. EFFECTS OF KELPS ON FLOW AND PARTICLE TRANSPORT NEAR THE BOTTOM.
Skidaway Inst. of Oceanography, Savannah, GA.
For primary bibliographic entry see Field 2L.
W90-02147

FORESTS AND WATER RESOURCES: PROBLEMS OF PREDICTION ON A REGIONAL SCALE.
Newcastle upon Tyne Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 4C.
W90-02149

MIST AND FOG INTERCEPTION IN ELFIN CLOUD FORESTS IN COLOMBIA AND VENEZUELA.
Universidad de Los Andes, Merida (Venezuela). Dept. de Biologia.
J. Cavelier, and G. Goldstein.
Journal of Tropical Ecology JTECEQ, Vol. 5, No. 3, p 309-322, August 1989. 8 fig, 43 ref.

Descriptors: *Colombia, *Venezuela, *Cloud forests, *Interception, Rainfall, Tropical regions, Epiphytes, Fog, Mist.

Fog interception and rainfall were measured during one year in three elfin cloud forests on small mountains along the Caribbean coast of South America and one in the Venezuelan Andes. While rainfall increases from west to east in the small mountains along the coast, fog interception decreases. In 1985, the total annual rainfall and fog interception were 853 mm and 796 mm in the cloud forests of Serrania de Macuira, 1630 mm and 518 mm in Cerro Santa Ana and 4461 mm and 480 mm in Cerro Copey. In the Andean forest of El Zumbador, the 1985 rainfall was 1983 mm and the annual fog interception was only 72 mm. Fog interception seems to be an important source of water to the elfin cloud forests of the small mountains which are surrounded by dry vegetation types and where the rainfall regime is highly seasonal. Fog interception increases with altitude (in the same mountain), exposure (windward slopes) and leaf inclination. These variations of fog interception could partially explain the observed distribution of epiphytic flora in some of these cloud forests. (Author's abstract)
W90-02206

IMPACT OF DURATION OF DRAINAGE ON THE SEED BANKS OF NORTHERN PRAIRIE WETLANDS.
Iowa State Univ., Ames. Dept. of Botany.
For primary bibliographic entry see Field 4D.
W90-02238

2J. Erosion and Sedimentation

TRACKING CALCIUM IN THE SAN JOAQUIN BASIN, CALIFORNIA: A STRONTIUM ISOTOPIC STUDY OF CARBONATE CEMENTS AT NORTH COLES LEVEE.
California Univ., Santa Barbara. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2H.
W90-01978

SULFATE REDUCTION AND THE FORMATION OF 35S-LABELED FES, FES2, AND S(0) (ELEMENTAL SULFUR) IN COASTAL MARINE SEDIMENTS.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2K.
W90-01993

MIXING ACROSS A LUTOCLINE.
Australian Inst. of Marine Sciences, Townsville.
E. Wolanski, T. Asaeda, and J. Imberger.
Limnology and Oceanography LIOCAH, Vol 34, No. 5, p 931-938, Jul 1989. 7 fig, 1 tab, 29 ref.

Descriptors: *Turbidity currents, *Density currents, *Mud-water interfaces, *Suspended sediments, *Mixing, Buoyancy, Turbulent flow, Settling velocity.

The results of a laboratory experiment showed that mixing across a lutocline (the interface between clear water on top and a fluid-mud mixture underneath) is controlled not only by mud-induced buoyancy effects through a Richardson-number dependence, but also by the sediment-induced collapse of turbulence in the fluid-mud layer. The dependence of particle settling velocity on the concentration of suspended sediment can limit the height of resuspension of sediments and stop lutocline erosion after an initial period of active mixing. (Author's abstract)
W90-01999

STREAM CHANNEL AND HABITAT CHANGES DUE TO FLOW AUGMENTATION.
Wyoming Water Research Center, Laramie.
S. W. Wolff, T. A. Wesche, and W. A. Hubert.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 225-233, September/October 1989. 3 fig, 3 tab, 18 ref.

Descriptors: *Stream fisheries, *Aquatic habitats, *Channel morphology, *Fish establishment, *Flow augmentation, *Flow control, *Wyoming, Interbasin transfers, Fisheries, Trout, Medicine Bow National Forest, Temperature, Beaver ponds, Physical Simulation System, Water diversion.

A previously ephemeral stream was used to convey water and create fish habitat as part of mitigation for impacts of a transbasin diversion project. The stream is the South Fork of Middle Crow Creek located in the Medicine Bow National Forest, Wyoming. Six Parshall flumes were installed in 1985 and 1986 to monitor the hydrologic response of the watershed to the increased flow; all flumes were equipped with water stage recorders for continuous monitoring. A thermograph was installed in the lower channelized sections of the study area in 1987 to monitor stream temperature. Evaluation of fish habitat development was divided into two categories, measurement of stream habitat and measurement of ponded habitat. After two years of increased flow to the 8.8 km study reach, the amount of stream channel had increased 32% and the total area of beaver ponds had more than doubled. Brook trout (Salvelinus fontinalis) stocked into the beaver ponds are surviving and growing. Factors limiting fishery development in the augmented stream include interrupted flow, discontinuous channels, and summer water temperature exceeding 25 C. When augmented flow was discontinued on the stream, even for 31 days, all of the beaver ponds maintained water. However, water levels in most ponds decreased and water temperature became elevated. Analysis using the Physical Simulation System indicated that a flow of 0.07 cu m/s would maximize the amount of weighted usable area for brook trout under the channel conditions present in 1987. The frequency and duration of interrupted discharge during the first two years indicated that a productive fishery will not develop if current water management policies are maintained. (White-Reimer-PTT)
W90-02043

TIME SERIES ANALYSES OF SUSPENDED SEDIMENT CONCENTRATIONS AT NORTH INLET, SOUTH CAROLINA.
South Carolina Univ., Columbia. Dept. of Geology.
L. R. Gardner, L. Thomas, D. Edwards, and D. Nelson.
Estuaries ESTUDO, Vol. 12, No. 4, p 211-221, Dec 1989. 3 fig, 4 tab, 38 ref. NSF grant DEB-8012165.

Descriptors: *Suspended sediments, *Estuaries, *Statistical analysis, *Time series analysis, *Turbidity, *Temperature effects, *Marshes, Salinity, Secchi disks, Particulate matter, Organic carbon, Water temperature, Tidal effects, Nearshore processes, Coastal waters, North Inlet, South Carolina, Rivers, Coastal marshes.

Daily water samples have been collected at three stations in the North Inlet (South Carolina) marsh estuary system since February 1981 as part of the National Science Foundation's Long-Term Ecological Research (LTER) project. As a result of this sampling regime, nearly continuous time series of inorganic and organic suspended sediment, particulate organic carbon (POC), Secchi disk, salinity, and water temperature are available. Power spectrum analysis of these data showed that most of the explainable variance in the inorganic suspended sediment, POC, and Secchi disk data is related to a yearly cycle that is strongly coherent with water temperature such that high turbidity is associated with high water temperature. Only a small fraction of the explainable variance is associated with frequencies that can be related to the semidiurnal tide. Simple correlation analysis also indicated that turbidity is more closely associated with water temperature than with tide height or salinity. The ratio of POC to inorganic suspended sediment shows no discernible power spectra peaks and is weakly, but inversely, correlated with temperature. From these results it is hypothesized that temperature-regulated bioturbation is the main factor controlling turbidity variations in the system. The lack of a strong inverse correlation between turbidity and salinity suggests that river runoff has little immediate impact on the suspended sediment of near-shore coastal waters in systems similar to North Inlet. (Author's abstract)
W90-02091

PATTERNS OF SEDIMENT DEPOSITION IN SUBSIDING COASTAL SALT MARSHES, TER-

REBONNE BAY, LOUISIANA: THE ROLE OF WINTER STORMS.
Louisiana Universities Marine Consortium, Chauvin.
D. J. Reed.
Estuaries ESTUDO, Vol. 12, No. 4, p 222-227, Dec 1989. 3 fig, 18 ref.

Descriptors: *Louisiana, *Sedimentation, *Terrebonne Bay, *Marshes, *Suspended sediments, *Sediment transport, *Wetlands, Water level, Sea level, Tidal effects, Floods, Flood frequency, Bays, Mississippi River, Deltas.

High rates of wetland loss in the Mississippi deltaic plain have been attributed to a combination of insufficient marsh sedimentation and relative sea-level rise rates of over 1.2 cm/yr. Contemporary patterns of sediment delivery to the marsh surface were examined by evaluating the contribution of individual marsh flooding events. Strong meteorological effects on water level in Terrebonne Bay often mask the usual microtidal fluctuations in water level and cause flood events to be of unpredictable frequency and duration. Sediment deposited on the marsh surface was collected weekly at two sites. Preliminary results allow the relative contribution of tidal and storm inundations to be calculated. Maximum sedimentation is associated with strong southerly winds both causing increased flooding and mobilizing sediment from open bay areas. Sediment deposition is limited by the availability of suspended sediment and the opportunity for its transport onto the marsh surface. (Author's abstract)
W90-02092

UNDERSTANDING SALT-MARSH ACCRETION, SCOLT HEAD ISLAND, NORFOLK, ENGLAND.
Cambridge Univ. (England). Dept. of Geography.
D. R. Stoddart, D. J. Reed, and J. R. French.
Estuaries ESTUDO, Vol. 12, No. 4, p 228-236, Dec 1989. 6 fig, 1 tab, 21 ref.

Descriptors: *Wetlands, *Stratigraphy, *Accretion, *Marshes, *Sedimentation, *Salt marshes, Tidal effects, Sediment distribution, Hut Marsh, England.

Measurements of surface sediment accretion have been obtained for Hut Marsh, Scolt Head Island, Norfolk, England, using sand marker horizons. More than eighty 1 sq m marker sites were deployed in October 1983, and vertical accretion measured at them in April and October 1986 and April 1987. Elevations relative to Ordnance Datum were established by levelling each site at the time of deployment. Data collected between 1935 and 1957 on the same marsh show a clear relationship between marsh elevations and sedimentation. The results of the current more detailed study, presented as mean annual accretion rates, indicate a complex pattern of sediment distribution at this macrotidal location. These data, together with the results of tidal flow monitoring in the creeks on Hut Marsh, show the importance of spatial and temporal patterns of sediment delivery and variation in depositional processes in determining the distribution of sedimentation across the marsh surface. (Author's abstract)
W90-02093

PATTERNS OF SEDIMENT ACCUMULATION IN THE TIDAL MARSHES OF MAINE.
Maine Univ., Orono. Dept. of Geological Sciences.
M. E. Wood, J. T. Kelley, and D. F. Belknap.
Estuaries ESTUDO, Vol. 12, No. 4, p 237-246, Dec 1989. 8 fig, 2 tab, 42 ref. Sea Grant College Program NA 86AA-D-5G047 and NSF grant RII-80-11448.

Descriptors: *Wetlands, *Sedimentation rates, *Marshes, *Salt marshes, *Ice, Sea level, Detritus, Maine, Sediment transport, Coastal marshes, Tidal effects.

One year's measurements of surficial sedimentation rates for 26 Maine marsh sites were made over marker horizons of brick dust. Observed sediment accumulation rates, from 0 to 13 mm/yr, were compared with marsh morphology, local relative sea-level rise rate, mean tidal range, and ice rafting activity. Marshes with four different morphologies (back-barrier, fluvial, bluff-toe, and transitional) showed distinctly different sediment accumulation rates. In general, back-barrier marshes had the highest accumulation rates and bluff-toe marshes had the lowest rates, with intermediate values for transitional and fluvial marshes. No causal relationship between modern marsh accumulation rate and relative sea-level rise rate (from tide gauge records) was observed. Marsh accretionary balance (sediment accumulation rate minus relative sea-level rise rate) did not correlate with mean tidal range for this meso-tidal to macro-tidal area. Estimates of ice-rafted debris on marsh sites ranged from 0% to > 100% of measured surficial sedimentation rates, indicating that ice transport of sediment may make a significant contribution to surficial sedimentation on Maine salt marshes. (Author's abstract)
W90-02094

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. I. 137CS AND 210 PB TECHNIQUES.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
R. D. DeLaune, J. H. Whitcomb, W. H. Patrick, J. H. Pardue, and S. R. Pezeshki.
Estuaries ESTUDO, Vol. 12, No. 4, p 247-259, Dec 1989. 6 fig, 15 tab, 27 ref.

Descriptors: *Environmental impact, *Marshes, *Accretion, *Sedimentation, *Coastal marshes , *Canals, *Wetlands, Subsidence, Sea level, Isotope studies, Organic matter, Minerals, Water level, Gulf of Mexico, Louisiana, Peat.

The influence of canals on vertical marsh accretion, including mineral sediment and organic matter accumulation, was evaluated at three locations along the Louisiana coast representing different geographic regions. The isotopes 210Pb and 137 Cs were used to determine vertical accretion along transects representing a canal and a control site. Rapid rates of vertical accretion were measured at all sites and ranged from 0.47 cm/yr to 0.90 cm/ year. Results indicated that there was no measurable effect of canals on marsh accretionary processes. Greater variation in vertical accretion, including mineral sediment deposition and organic matter accumulation, was observed between geographical regions than between canal and control sites within a region. Statistical analysis of data suggest that any difference between canal and control site would be less than 0.20 cm/year. Such a change in marsh surface-water level relationships as a result of any canal influence on marsh accretionary processes would be less than reported eustatic sea-level rise for the Gulf of Mexico. Results suggest that any change in the marsh surface-water level relationship could be the influence of canals on local hydrology, resulting in increased water level rather than any appreciable reduction in accretionary processes. Such changes in hydrology under certain conditions could stress vegetation, resulting in marsh deterioration. (Author's abstract)
W90-02095

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND II. FELDSPAR MARKER HORIZON TECHNIQUE.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
D. R. Cahoon, and R. E. Turner.
Estuaries ESTUDO, Vol. 12, No. 4, p 260-268, Dec 1989. 1 fig, 5 tab, 28 ref. Department of the Interior contract 14-12-0001-30252.

Descriptors: *Environmental impact, *Marshes, *Accretion, *Sedimentation rates, *Canals, *Salt marshes, *Wetlands, Subsidence, Organic matter, Minerals, Spartina, Spoil banks, Spatial distribution, Erosion.

Recent (6-12 month) marsh sediment accretion and accumulation rates were measured with feldspar marker horizons in the vicinity of natural waterways and man-made canals with spoil banks in the rapidly subsiding environment of coastal Louisiana. Annual accretion rates in a Spartina alterniflora salt marsh in the Mississippi deltaic plain averaged 6 mm in marsh adjacent to canals compared to 10 mm in marsh adjacent to natural waterways. The rates, however, were not statistically significantly different. The average rate of sediment accretion in the same salt marsh region for a transect perpendicular to a canal (13 mm/yr) was significantly greater than the rate measured for a transect perpendicular to a natural waterway (7 mm/ yr). Measurements of soil bulk density and organic matter content from the two transects were also different. This spatial variability in accretion rates is probably related to (1) spoil bank influences on local hydrology; and (2) a locally high rate of sediment input from lateral erosion associated with pond enlargements. In a brackish Spartina patens marsh on Louisiana's Chenier plain, vertical accretion rates were the same along natural and canal waterways (3-4 mm/yr) in a hydrologically restricted marsh region. However, the accretion rates for both waterways were significantly lower than the rates along a nonhydrologically restricted natural waterway nearby (11 mm/yr). The vertical accretion of matter displayed semi-annual differences in the brackish marsh environment. (Author's abstract)
W90-02096

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. III. A NEW SOIL HORIZON MARKER METHOD FOR MEASURING RECENT ACCRETION.
Louisiana State Univ., Baton Rouge. Nuclear Science Center.
R. M. Knaus, and D. L. Van Gent.
Estuaries ESTUDO, Vol. 12, No. 4, p 269-283, Dec 1989. 13 fig, 1 tab, 26 ref. Department of the Interior grant 14-12-0001-30252.

Descriptors: *Environmental impact, *Accretion, *Marshes, *Sedimentation rates, *Neutron activation analysis, *Canals, Wetlands, Subsidence, Rare earth elements, Salt marshes, Soil horizons.

A new methodology was used on a large scale in which short-term (< 1 yr) marsh accretion rates were measured in saltwater and brackish marshes and compared to first-time measurements made in freshwater marshes. The stable rare-earth elements (REE) dysprosium and samarium were used for soil horizon markers that were collected by a cryogenic field coring method and detected by instrumental neutron activation analysis (INAA). Accumulation in saltwater marshes for 6 months was 0.76 +/-0.26 cm (n = 11) and accumulation for 1 year was 1.29 +/-0.49 cm (n = 7). Accumulation in brackish marshes for 6 months was 0.51 +/-0.34 (n = 6) and for 1 year, 0.84 +/-0.32 cm (n = 10). These data from saline and brackish environments can be compared to first-time measurements of accumulation in a freshwater marsh of 1.53 +/-0.66 mc (n = 8) for 6-month accumulation and 2.97 +/-0.92 cm (n = 11) for 1-year accumulation. The cryogenic REE-INAA method for sampling and measuring 6-month and 1-year accretion is nonpolluting, does not alter natural marsh soil processes, and is effective in salt, brackish, and freshwater marshes. Additionally, the marker is essentially immobile, long lasting in the soil profile, and inexpensive to buy, apply, and sample. INAA analysis of the cores is expensive and time-consuming, yet the REE-INAA method yields accretion data, especially in freshwater habitats, that are obtainable in no other way. A comparison between short-term accretion and the presence or absence of man-made canals showed no statistically significant difference of accretion along transects from 0-m to 5-m distance into brackish and saltwater marshes (no freshwater transects were established). Sediment depositions measured at 50 m into fresh, brackish, and saltwater marshes from natural or man-made waterways showed no statistically significant differences of accretion within each habitat over a 6-month or a 1-year period. (Author's abstract)
W90-02097

RECENT ACCRETION IN MANGROVE ECOSYSTEMS BASED ON 137 CS AND 210 PB.
University of Southwestern Louisiana, Lafayette. Dept. of Biology.
J. C. Lynch, J. R. Meriwether, B. A. McKee, F. Vera-Herrera, and R. R. Twilley.
Estuaries ESTUDO, Vol. 12, No. 4, p 284-299, Dec 1989. 5 fig, 5 tab, 39 ref. NOAA grant 86AA.

Descriptors: *Wetlands, *Accretion, *Mangrove swamps, *Sedimentation rates, *Coastal marshes, *Isotope studies, Gulf of Mexico, Tidal effects, Subsidence, Estuaries, Spatial distribution.

Accretion rates were measured in fringe and basin mangrove forests in river and tidally dominated sites in Terminos Lagoon, Mexico, and a basin mangrove forest in Rookery Bay, Florida. Accretion rates were determined using the radionuclides 210Pb and 137 Cs. Consolidation-corrected accretion rates for the Rookery Bay cores ranged from 1.4 to 1.7 m/yr, with an average rate of 1.6 mm/yr. Rates at the Mexico sites ranged from 1.0 to 4.4 mm/yr, with an average of 2.4 mm/yr. Determination of rates in these mangrove forests was greatly affected by the consolidation corrections which decreased the apparent accretion rate by > 50% in one case. Accretion rates at basin sites compare favorably with a reported 1.4 to 1.6 mm/yr rate of sea-level rise, indicating little or no subsidence at inland locations. Accretion rates in fringe sites are generally greater than basin sites, indicating greater subsidence rates in these sediments over longer time intervals. (Author's abstract)
W90-02098

ACCRETION RATES AND SEDIMENT ACCUMULATION IN RHODE ISLAND SALT MARSHES.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
S. Bricker-Urso, S. W. Nixon, J. K. Cochran, D. J. Hirschberg, and C. Hunt.
Estuaries ESTUDO, Vol. 12, No. 4, p 300-317, Dec 1989. 12 fig, 5 tab, 82 ref.

Descriptors: *Wetlands, *Accretion, *Sedimentation rates, *Marshes, *Estuaries, *Narragansett Bay, Isotope studies, Lead radioisotopes, Model studies, Sea level, Copper, Organic matter.

210Pb analyses were carried out and accretion rates calculated using constant flux and constant activity models applied to sediment cores collected from low Spartina alterniflora marshes at four sites from the head to the mouth of Narragansett Bay. A core was also collected from a high Spartina patens marsh at one site. Additional low marsh cores from a tidal river entering the bay and a coastal lagoon on Block Island Sound were also analyzed. Accretion rates for all cores were also calculated from copper concentration data assuming that anthropogenic copper increases began at all sites between 1865 and 1885. During the past 60 yr, accretion rates at the eight low marsh sites averaged 0.43 +/-0.13 cm/yr based on the constant flux model, 0.40 +/-0.15 cm/yr based on the constant activity model, and 0.44 +/-0.11 cm/yr based on copper concentration data, with no apparent trend down-bay. High marsh rates were 0.24 +/-0.02 (constant flux), 0.25 +/-0.01 (constant activity), and 0.47 +/-0.04 (copper concentration data). The cores showing closest agreement between the three methods are those for which the excess 210Pb inventories are consistent with atmospheric inputs. These rates compare to a tide gauge record from the mouth of the bay that shows an average sea-level-rise of 0.26 +/-0.02 cm/yr from 1931 to 1986. Low marshes in this area appear to accrete at rates 1.5-1.7 times greater than local relative sea-level rise, while the high marshes accretion rate is equal to the rise in sea level. Inorganic and organic dry solids each contributed about 9% by volume to low marsh accretion, while organic dry solids contributed 11% and inorganic 4% to high marsh accretion. Water/pore space accounted for the majority of accretion in both low and high marshes. Organic matter accounts for an average of 91% of low marsh and 96% of high marsh accretion. A dramatic increase in the organic content at a depth of 60 to 90 cm in the cores from Narragansett Bay appears to mark the start of marsh development on prograding sand flats. (Author's abstract)
W90-02099

UNUSUAL MARINE EROSION IN SAN DIEGO COUNTY FROM A SINGLE STORM.
Scripps Institution of Oceanography, La Jolla, CA.
P. K. Dayton, R. J. Seymour, P. E. Parnell, and M. J. Tegner.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 2, p. 151-160, Aug 1989. 2 fig, 1 tab, 1 plate, 14 ref. Grant No. NA80AA-D-00120.

Descriptors: *Beach erosion, *California, *Coastal waters, *Storms, Sediment transport, Nearshore processes.

Observations of wave-induced geological damage were made along the San Diego coastline to a depth of 25m, following the storm of 17-18 January, 1988. Massive damage to limestone reefs occurred, including the shearing of individual sections with in-water weights of over 20 tons at the remarkable depth of at least 22 m. Large sections of the walls of a submarine canyon were broken off at a depth exceeding 20 m. The drag and inertial forces from the waves in this storm are shown to be about twice those in the largest previous storms of the century, and it appears to be a 200 year event. In addition to the kelp mortality reported in Seymour et al., 1989, there was extensive mortality among encrusting algal and animal communities. The apparent age of the mature successional communities in the deeper sites supports the engineering estimates of the rarity of this event. The movement of cobbles and boulders at depths almost twice as great as the previously assumed limits on effective sediment transport may require coastal engineers to revise cross-shore transport models. (Author's abstract)
W90-02138

EFFECT OF SUSPENDED SEDIMENT CONCENTRATION ON THE SEDIMENT TO WATER PARTITION COEFFICIENT FOR 1,3,6,8-TETRACHLORODIBENZO-P-DIOXIN.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5B.
W90-02145

RUNOFF AND EROSION CONTROL IN POTATO FIELDS.
Agricultural Research Organization, Bet-Dagan (Israel).
For primary bibliographic entry see Field 4D.
W90-02154

URANIUM DEPOSITION IN SAANICH INLET SEDIMENTS, VANCOUVER ISLAND.
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 2K.
W90-02171

BED MATERIAL SAMPLING ERROR IN SAND BED RIVERS.
University of Western Ontario, London. Dept. of Geography.
For primary bibliographic entry see Field 7A.
W90-02198

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ELBE RIVER SUSPENDED PARTICULATE MATTER SEPARATED ACCORDING TO THE SETTLING VELOCITIES.
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik.
For primary bibliographic entry see Field 5B.
W90-02205

STUDY OF RAINFALL SIMULATORS, RUNOFF AND EROSION PROCESSES, AND NUTRIENT YIELDS ON SELECTED SITES IN ARIZONA AND NEW MEXICO.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
For primary bibliographic entry see Field 2A.
W90-02316

RIVER MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 2E.
W90-02360

PHYSICAL MODELLING OF LITTORAL PROCESSES.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-02367

FLOODPLAIN HARMONY.
For primary bibliographic entry see Field 6F.
W90-02368

FLOODPLAINS AND NATURAL HAZARD MANAGEMENT: THE DECADE AHEAD.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 6F.
W90-02373

EVALUATING FLOOD HAZARDS ON ALLUVIAL FANS.
Baker (Michael), Jr., Inc., Alexandria, VA.
For primary bibliographic entry see Field 2E.
W90-02399

DESIGN DEPTHS AND VELOCITIES ON ALLUVIAL FANS.
Baker (Michael), Jr., Inc., Beaver, PA.
For primary bibliographic entry see Field 2E.
W90-02400

EFFICIENT PROGRAM FOR SIMULTANEOUS PREDICTION OF HURRICANE STORM TIDE, BEACH EROSION, AND WAVE EFFECTS.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
For primary bibliographic entry see Field 2L.
W90-02404

EVOLUTION OF KNICK-POINT BELT IN A RIVER SECTION IN HUANGGUOSHU.
Academia Sinica, Guiyang (China). Karst Research Office.
For primary bibliographic entry see Field 2F.
W90-02468

KARST DEVELOPMENT IN PERMAFROST REGIONS OF NORTHERN CANADA.
Carleton Univ., Ottawa (Ontario). Dept. of Earth Sciences.
F. A. Michel, and R. O. van Everdingen.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 249-254. 8 ref.

Descriptors: *Geomorphology, *Permafrost, *Geochemistry, *Karst hydrology, *Karst, *Canada, *Geohydrology, Groundwater movement, Caves, Intermittent lakes.

Most of northern Canada is currently underlain by permafrost. However, karst development is still occurring in most regions of carbonate terrain with moderate to high relief. Cave development solely within carbonates is actively occurring in the northern Cordillera with extensive spectacular karst reported near the South Nahanni River. Karst-related groundwaters in this area have short residence times, and a calcium, magnesium, bicarbonate composition. Within the Mackenzie Valley and Interior Plains many groundwaters indicate continuing dissolution of gypsum (or anhydrite)

and halite units. Extensive dissolution of these evaporites has led to collapse of overlying carbonates and the formation of seasonal lakes in the depressions. (See also W90-02444) (Author's abstract)
W90-02470

EVOLUTION OF KARST AND ITS PRACTICAL SIGNIFICANCE IN HYDROGEOLOGICAL INVESTICATION.
Karlova Univ., Prague (Czechoslovakia). Dept. of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-02471

RELATION BETWEEN THE HYDROGEOLOGY OF CARBONATE ROCKS AND THE DEVELOPMENT OF KARST LANDFORMS.
Geological Survey, Nashville, TN.
For primary bibliographic entry see Field 2F.
W90-02472

DISSOLUTION-RATES IN SPANISH KARST REGIONS.
For primary bibliographic entry see Field 2E.
W90-02473

HYDROLOGICAL CONTROL AND THE DEVELOPMENT OF COCKPIT AND TOWER KARST.
Auckland Univ. (New Zealand). Dept. of Geography.
For primary bibliographic entry see Field 2F.
W90-02474

SPELEOLOGICAL EXPLORATION OF OGULIN AREA.
Student Mountaineering Society, Zagreb (Yugoslavia).
For primary bibliographic entry see Field 2F.
W90-02475

SOME CHARACTERISTICS OF SILT OF SUBTERRANEAN SYSTEM OF DJULA-MEDVEDICA IN OGULIN YUGOSLAVIA.
Forest Research Inst., Zagreb (Yugoslavia). Dept. of Typology.
For primary bibliographic entry see Field 5B.
W90-02476

2K. Chemical Processes

IN SITU FLUCTUATIONS OF OXYGEN AND SULPHIDE IN MARINE MICROBIAL SEDIMENT ECOSYSTEMS.
Groningen Rijksuniversiteit (Netherlands). Dept. of Microbiology.
For primary bibliographic entry see Field 2L.
W90-01963

GROUNDWATER CHEMISTRY AND WATER-ROCK INTERACTIONS AT STRIPA.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W90-01968

FLUID INCLUSIONS IN THE STRIPA GRANITE AND THEIR POSSIBLE INFLUENCE ON THE GROUNDWATER CHEMISTRY.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W90-01969

DEUTERIUM, OXYGEN-18, AND TRITIUM IN STRIPA GROUNDWATER.
Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Hydrologie.
For primary bibliographic entry see Field 2F.
W90-01970

ISOTOPE GEOCHEMISTRY OF CARBON IN GROUNDWATER AT STRIPA.
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-01971

AQUEOUS SULPHATES FROM THE STRIPA GROUNDWATER SYSTEM.
Paris-11 Univ., Orsay (France). Lab. d'Hydrologie et de Geochemie Isotopique.
For primary bibliographic entry see Field 2F.
W90-01972

NATURAL RADIOELEMENT SOLUTION BY CIRCULATING GROUNDWATERS IN THE STRIPA GRANITE.
Bath Univ. (England). School of Chemistry.
For primary bibliographic entry see Field 2F.
W90-01973

IN SITU PRODUCTION AND MIGRATION OF I129 IN THE STRIPA GRANITE, SWEDEN.
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W90-01974

ARGON-39, ARGON-37 AND KRYPTON-85 ISOTOPES IN STRIPA GROUNDWATERS.
Bern Univ. (Switzerland). Physikalisches Inst.
For primary bibliographic entry see Field 2F.
W90-01975

ATMOSPHERIC AND RADIOGENIC GASES IN GROUNDWATERS FROM THE STRIPA GRANITE.
Bath Univ. (England). School of Chemistry.
For primary bibliographic entry see Field 2F.
W90-01976

EARLY DIAGENESIS OF LEAD IN LAURENTIAN TROUGH SEDIMENTS.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
C. Gobeil, and N. Silverberg.
Geochimica et Cosmochimica Acta GCACAK, Vol 53, No. 8, p 1889-1895, Aug 1989. 6 fig, 1 tab, 41 ref.

Descriptors: *Water chemistry, *Geochemistry, *Sediment-water interfaces, *Lead, *Iron, *Cadmium, *Heavy metals, Bottom sediments, Diagenetic changes, Mobility, Fixation, Hydrogen ion concentration, Solubility.

The depth distributions of various solid-phase and porewater fractions of Pb, Fe and Cd in boxcores from three stations in the Laurentian Trough demonstrate that Pb is subject to early diagenetic change. High total-Pb concentrations, compared to background levels, indicate that much of the Pb in these cores is of anthropogenic origin. Patterns of mobilization and fixation, and of changes in the chemical reactivity towards extractants, are consistent from core to core. Pb is mobilized both near the sediment surface and at intermediate depth. In these zones dissolved Pb concentrations attain levels of 8-13.5 nM, which are two orders of magnitude greater than in the overlying bottom waters of the Laurentian Trough (0.1 nM). A fraction of Pb, soluble in a pH 5 sodium acetate-acetic acid solution, is produced diagenetically within the sediment. It is most abundant at intermediate depth, where it accounts for as much as 31% of the total Pb. Another fraction, soluble in hydroxylamine hydrochloride-acetic acid solution, decreases in abundance with depth. Flux calculations indicate that significant amounts of Pb are subject to post-depositional transformation. Parallels in the vertical distribution of the various fractions suggest that some Pb, like Cd, is mobilized near the sediment surface during the aerobic degradation of organic matter and that other forms are implicated in the redox-controlled cycles of Fe diagenesis. (Author's abstract)
W90-01977

SULFATE REDUCTION AND THE FORMATION OF 35S-LABELED FES, FES2, AND S(0) (ELEMENTAL SULFUR) IN COASTAL MARINE SEDIMENTS.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
S. Thode-Andersen, and B. B. Jorgensen.
Limnology and Oceanography LIOCAH, Vol. 34, No. 5, p 793-806, Jul 1989. 7 fig, 2 tab, 39 ref.

Descriptors: *Water chemistry, *Geochemistry, *Diagenesis, *Sulfates, *Marine sediments, *Radioactivity techniques, Coastal waters, Sulfides, Denmark.

A comparative survey was done of the formation of radiolabeled end-products during 35SO4(2-) reduction measurements in coastal sediments of Denmark. The distribution of reduced 35S in acid-volatile sulfides (AVS), pyrite, and elemental sulfur in the upper 0-15 cm of sediment depended on the sulfur chemistry and on the overall sulfate reduction rates. In sediments with relatively low metabolic rates, undetectable H2S, and low FeS:FeS2 ratio (<1:20), only 32-55% of the reduced 35S was recovered in the AVS pool. In sediments with high metabolic rates, high H2S, and high FeS:FeS2 ratio (>1:10), the 35S recovery in AVS was 63-92%. The relative contribution of 35S-labeled FeS2 formation showed little depth dependence, whereas the formation of 35S(0) was highest in the more oxidizing sediment layers near the surface. Inclusion of 35S-labeled FeS2 and S(0) in the sulfate reduction measurement yields more accurate rate data than are obtained from AVS alone. Due to possible isotopic exchange reactions and unknown pathways of H2S transformation into AVS, S(0) and FeS2, however, the radioactivities of the three pools cannot be used directly to calculate their differential rates of formation. (Author's abstract)
W90-01993

GAS TRANSPORT FROM METHANE-SATURATED, TIDAL FRESHWATER AND WETLAND SEDIMENTS.
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W90-01994

CYCLING OF ORGANIC CARBON IN THE PHOTIC ZONE OF A EUTROPHIC LAKE WITH SPECIAL REFERENCE TO THE HETEROTROPHIC BACTERIA.
Trondheim Univ. (Norway). Lab. of Biotechnology.
For primary bibliographic entry see Field 2H.
W90-01996

GENERAL PATTERNS IN THE SEASONAL DEVELOPMENT OF CHLOROPHYLL A FOR TEMPERATE LAKES.
McGill Univ., Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W90-01997

CHEMICAL COMPOSITION AND PHOSPHATE UPTAKE KINETICS OF LIMNETIC BACTERIAL COMMUNITIES CULTURED IN CHEMOSTATS UNDER PHOSPHORUS LIMITATION.
Trondheim Univ. (Norway). Lab. of Biotechnology.
For primary bibliographic entry see Field 2H.
W90-02000

HIGH LONG-TERM NITRATE UPTAKE BY OYSTER-POND MICROALGAE IN THE PRESENCE OF HIGH AMMONIUM CONCENTRATIONS.
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest.
Y. Collow, S. Y. Maestrini, and J.-M. Robert.
Limnology and Oceanography LIOCAH, Vol. 34, No. 5, p 957-964, Jul 1989. 8 fig, 3 tab, 33 ref.

Descriptors: *Nitrates, *Ammonium, *Algae, Shellfish farming, Diatoms, Oysters.

Natural assemblages and axenic cultures of oyster-pond microalgae (dominated by pennate diatoms) were subjected to nutrient pulses in which the concentrations of ammonium and nitrate simulated the natural pulses to which these populations are regularly exposed. In natural populations, nitrate uptake (per unit of Chl a or particulate N) always presented a maximum at ammonium levels between 10 and 30 microg-atoms N/L. Such maxima coincided either with the maximal ammonium uptake rate or with the start of a decrease in ammonium uptake. Nitrate uptake then decreased and went through a secondary maximum at lower ammonium levels. Although species succession could not be ruled out as a possible cause for these patterns, 48-69% of the variability in nitrate uptake could be explained by variations in the concentration of nitrate relative to the sum of nitrate and ammonium, corrected for biomass increases. In axenic cultures of three species of diatoms isolated from these environments, this percentage varied between 78 and 99%. (Author's abstract)
W90-02001

WATER QUALITY, SEDIMENTS AND THE MACROINVERTEBRATE COMMUNITY OF RESIDENTIAL CANAL ESTATES IN SOUTH-EAST QUEENSLAND, AUSTRALIA: A MULTIVARIATE ANALYSIS.
Queensland Dept. of Environment, Conservation and Tourism, Brisbane (Australia). Div. of Environment.
For primary bibliographic entry see Field 2L.
W90-02006

PHYSICAL CONTROL ON HYDROCHEMICAL VARIABILITY IN THE INNER BLUEGRASS KARST REGION OF CENTRAL KENTUCKY.
Texas Univ. at Austin. Bureau of Economic Geology.
For primary bibliographic entry see Field 2F.
W90-02021

GEOCHEMICAL COMPARISON OF GROUND WATER IN AREAS OF NEW ENGLAND, NEW YORK, AND PENNSYLVANIA.
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W90-02027

CHEMICAL RESPONSE FOLLOWING BASE APPLICATION TO LITTLE SIMON POND, NEW YORK STATE.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
For primary bibliographic entry see Field 5G.
W90-02105

EFFECTS OF SITE VARIATIONS ON SUBSURFACE BIODEGRADATION POTENTIAL.
CH2M/Hill, Corvallis, OR.
For primary bibliographic entry see Field 5B.
W90-02106

STATISTICAL MODELLING OF WATER COLOR IN THE UPLANDS: THE UPPER NIDD CATCHMENT 1979-1987.
Institute of Hydrology, Wallingford (England).
P. S. Naden, and A. T. McDonald.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 141-163, 1989. 10 fig, 7 tab, 21 ref.

Descriptors: *Water quality, *Color, *Iron, *Aluminum, *England, Potable water, Seasonal variation, Soil water, Water table, Peat, Aerobic conditions, Rainfall.

The increasing color of raw water from the uplands is a matter of concern to water managers. An examination of the color record for the period 1979-1987 for the catchments of Upper Nidderdale, North Yorkshire shows the variation in color has a marked seasonality with peaks occurring during the autumn months. No long-term sustained increase in color is found although the color levels were high in 1980, 1985, and 1987. Color is found to be highly correlated with iron and more particularly, aluminum. There is no relationship between color levels and erosion on the catchments. Color increases appear to relate to large soil moisture deficits in the previous year. Complementary relationships are found between monthly rainfall totals and colors. In the light of these findings, it is suggested that high color is associated with water table lowering and aerobic decomposition of the upper organic peat layers. (Author's abstract)
W90-02117

DETERMINATION OF LEAD-210, BISMUTH-210 AND POLONIUM-210 IN NATURAL WATERS AND OTHER MATERIALS BY ELECTROCHEMICAL SEPARATION.
Florida State Univ., Tallahassee. Dept. of Oceanography.
For primary bibliographic entry see Field 7B.
W90-02135

INFLUENCE OF MACROMOLECULES ON CHEMICAL TRANSPORT.
Robert S. Kerr Environmental Research Lab., Ada, OK.
For primary bibliographic entry see Field 5B.
W90-02144

EFFECT OF SUSPENDED SEDIMENT CONCENTRATION ON THE SEDIMENT TO WATER PARTITION COEFFICIENT FOR 1,3,6,8-TETRACHLORODIBENZO-P-DIOXIN.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5B.
W90-02145

NATURALLY OCCURRING PROTEINS FROM POND WATER SENSITIZE HEXACHLOROBENZENE PHOTOLYSIS.
Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry.
For primary bibliographic entry see Field 5B.
W90-02146

ANALYSIS OF SUMMERTIME CLOUD WATER MEASUREMENTS MADE IN A SOUTHERN APPALACHIAN SPRUCE FOREST.
Tennessee Valley Authority, Muscle Shoals, AL. Atmospheric Science Dept.
For primary bibliographic entry see Field 5A.
W90-02155

SELENATE REDUCTION TO ELEMENTAL SELENIUM BY ANAEROBIC BACTERIA IN SEDIMENTS AND CULTURE: BIOGEOCHEMICAL SIGNIFICANCE OF A NOVEL, SULFATE-INDEPENDENT RESPIRATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
R. S. Oremland, J. T. Hollibaugh, A. S. Maest, T. S. Presser, and L. G. Miller.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2333-2343, September 1989. 7 fig, 6 tab, 51 ref.

Descriptors: *Anaerobic bacteria, *Sediments, *Interstitial water, *Selenium, *Geochemistry, *Fate of pollutants, *Path of pollutants, *Water chemistry, Estuaries, Wastewater treatment, Water treatment, Respiration.

Interstitial water profiles of SeO4(--), SeO3(--), SO4(--), and Cl(-) in anoxic sediments indicated removal of the seleno-oxyanions by a near-surface process unrelated to sulfate reduction. In sediment slurry experiments, a complete reductive removal of SeO4(--) occurred under anaerobic conditions, was more rapid with H2 or acetate, and was inhibited by O2, NO3(-), MnO2, or autoclaving but not by SO4(--) or FeOOH. Oxidation of acetate in sediments could be coupled to selenate but not to molybdate. Reduction of selenate to elemental Se was determined to be the mechanism for loss from solution. Selenate reduction was inhibited by tungstate and chromate but not by molybdate. A small quantity of the elemental Se precipitated into sediments from solution could be resolubilized by oxidation with either nitrate or FeOOH, but not with MnO2. A bacterium isolated from estuarine sediments demonstrated selenate-dependent growth on acetate, forming elemental Se and CO2 as respiratory end products. These results indicate that dissimilatory selenate reduction to elemental Se is the major sink for selenium oxyanions from wastewaters and also offer an explanation for the presence of selenite in oxic waters. (Sand-PTT)
W90-02168

URANIUM DEPOSITION IN SAANICH INLET SEDIMENTS, VANCOUVER ISLAND.
Lamont-Doherty Geological Observatory, Palisades, NY.
R. F. Anderson, A. P. LeHuray, M. Q. Fleisher, and J. W. Murray.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 9, p 2205-2213, September 1989. 7 fig, 2 tab, 49 ref. NSF grants OCE84-16258 and OCE86-01213.

Descriptors: *Marine sediments, *Geochemistry, *Uranium, *Precipitation, *Interstitial water, *Sediment-water interfaces, Uranium radioisotopes, Saanich Inlet, Vancouver Island.

Deposition in organic-rich sediments is a major sink for uranium in the ocean. Uranium concentrations and U234/U238 ratios of particulate matter collected by sediment traps and U concentrations in sediment pore waters collected in situ in Saanich Inlet were measured to study the process of U deposition in anoxic marine basins. The results provided direct evidence for two previously hypothesized mechanisms of U deposition in organic-rich sediments. Dissolved U is incorporated into particles in surface waters, possibly in association with autochthonous organic matter. Fluxes of particulate authigenic U ranged between 0.025 and 0.4 dpm U238/sq cm/yr, with lowest fluxes occurring during winter months. Particulate U fluxes collected in the upper oxic water column and the lower anoxic waters were not significantly different, indicating that chemical scavenging of U by particles settling through the anoxic H2S-bearing bottom waters of Saanich Inlet contributes negligibly to the total particulate U flux. Dissolved U also diffuses into the sediments where it is precipitated. The calculated diffusive flux of U into the sediments (0.0053 dpm U238/sq cm/yr) is much smaller than the particulate U flux from the water column, and the sum of these two fluxes is less than the rate of authigenic U burial in the sediments (0.48 dpm U238/sq cm/yr), suggesting that an additional mechanism of U precipitation may be taking place at, or near, the sediment-water interface. The pore water data are consistent with thermodynamic predictions that U should be reduced and precipitated under the Eh and pH conditions of the sediments and suggest that previous studies which have indicated a flux of dissolved U out of anoxic marine sediments suffered from serious sampling artifacts. (Author's abstract)
W90-02171

CONCENTRATION, OXIDATION STATE, AND PARTICULATE FLUX OF URANIUM IN THE BLACK SEA.
Lamont-Doherty Geological Observatory, Palisades, NY.
R. F. Anderson, M. Q. Fleisher, and A. P. LeHuray.
Geochimica et Cosmochimica Acta GCACAK, Vol. 53, No. 9, p 2215-2224, September 1989. 4 fig, 4 tab, 54 ref. NSF grants OCE82-00141, OCE84-10819 and OCE86-01213.

Descriptors: *Marine sediments, *Geochemistry, *Uranium, *Precipitation, *Interstitial water, *Sediment-water interfaces, Hydrogen sulfide, Black Sea.

In contrast to its unreactive behavior in the open ocean, uranium is removed from seawater to sediments of anoxic marine basins. Four biogeochemical processes have been proposed to account for this removal: active uptake by organisms whose remains are preserved by the anoxic conditions of the sediments; complexation of U(VI) by particulate organic matter; chemical reduction of soluble U(VI) to insoluble U(IV) which is scavenged to the sediments by settling particles; and precipitation of U within the sediments themselves. The Black Sea is the largest anoxic marine basin in the world. Waters below 150-200 m are anoxic and H2S levels build up to about 400 micromol/l in the bottom water (maximum depth 2200 m). Concentrations of total U and the oxidation state of dissolved U were measured throughout the water column while particulate U fluxes were determined from time series sediment trap samples collected in the deep anoxic zone. Bottom waters were depleted in U by 40% relative to the initial U content of the water. Two independent methods gave residence times of dissolved U in the deep-water column of about 1000 years. U occurred throughout the water column as soluble, chemically labile (reducible) U(VI) rather than the thermodynamically favored U(IV). Fluxes of particulate authigenic U measured with sediment traps are at least two orders of magnitude less than the rate of authigenic U burial in Black Sea sediments. Therefore, the first three processes listed above contribute negligibly to the deposition of U in the sediments of anoxic marine basins such as the Black Sea. The dominant removal process must involve precipitation of U in the sediments rather than scavenging from the water column. (Author's abstract)
W90-02172

REACTIVE IRON TRANSPORT IN AN ACIDIC MOUNTAIN STREAM IN SUMMIT COUNTY, COLORADO: A HYDROLOGIC PERSPECTIVE.
Geological Survey, Denver, CO.
D. M. McKnight, and K. E. Bencala.
Geochimica et Cosmochimica GCACAK, Vol. 53, No. 9, p 2225-2234, September 1989. 7 fig, 5 tab, 25 ref.

Descriptors: *Solute transport, *Iron oxides, *Acidic water, *Acid streams, *Mountain streams, *Geochemistry, Hydrogen ion concentration, Colorado, Snake River.

A pH perturbation experiment was conducted in an acidic, metal-enriched, mountain stream (Snake River in Colorado) to identify relative rates of chemical and hydrologic processes as they influence iron transport. During the experiment the pH was lowered from 4.2 to 3.2 for 3 hours by injection of sulfuric acid. Amorphous iron oxides are abundant on the streambed, and dissolution and photoreduction reactions resulted in a rapid increase in the dissolved iron concentration. The increase occurred simultaneously with the decrease in pH. Ferrous iron was the major aqueous iron species. The changes in the iron concentration during the experiment indicate that variation exists in the solubility properties of the hydrous iron oxides on the streambed with dissolution of at least two compartments of hydrous iron oxides contributing to the iron pulse. Spatial variations of the hydrologic properties along the stream were quantified by simulating the transport of a coinjected tracer, lithium. A simulation of iron transport, as a conservative solute, indicated that hydrologic transport had a significant role in determining downstream changes in the iron pulse. The rapidity of the changes in iron concentration indicates that a model based on dynamic equilibrium may be adequate for simulating iron transport in acid streams. A major challenge for predictive solute transport models of geochemical processes may be due to substantial spatial and seasonal variations in chemical properties of the reactive oxides in such streams and in the physical and hydrologic properties of the stream. (Author's abstract)
W90-02173

TRANSFORMATIONS OF SULFUR COMPOUNDS IN MARSH-FLAT SEDIMENTS.
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
For primary bibliographic entry see Field 2L.
W90-02174

CHANGES IN THE CHEMICAL COMPOSITION OF STREAM WATER IN TWO CATCHMENTS IN THE SHENANDOAH NATIONAL PARK, VIRGINIA, IN RESPONSE TO ATMOSPHERIC DEPOSITION OF SULFUR.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W90-02187

NUMERICAL ANALYSIS OF SOLUTE TRANSPORT DURING TRANSIENT IRRIGATION: 2. THE EFFECT OF IMMOBILE WATER.
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
For primary bibliographic entry see Field 5B.
W90-02190

DENSITY-DRIVEN FLOW OF GAS IN THE UNSATURATED ZONE DUE TO THE EVAPORATION OF VOLATILE ORGANIC COMPOUNDS.
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5B.
W90-02194

DETERMINATION OF MOLYBDENUM IN ESTUARINE WATERS USING CATHODIC STRIPPING VOLTAMMETRY.
Liverpool Univ. (England). Oceanography Lab.
For primary bibliographic entry see Field 7B.
W90-02212

PROCESSES CONTROLLING THE CONCENTRATIONS OF SO4(--), NO3(-), NH4(+), H(+), HCOO-T AND CH3COO-T IN PRECIPITATION ON BERMUDA.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
J. N. Galloway, W. C. Keene, R. S. Artz, J. M. Miller, and T. M. Church.
Tellus TELLAL, Vol. 41B, No. 4, p 427-443, September 1989. 14 fig, 5 tab, 39 ref.

Descriptors: *Path of pollutants, *Bermuda, *Air pollution, *Acid rain, *Chemistry of precipitation, *Sulfates, Nitrates, Ammonium, Organic acids, Acetic acid, Formic acid, Precipitation.

The composition of precipitation on Bermuda can be characterized as a slightly acidic, dilute seawater solution. The acidity of the solution is controlled by H2SO4, HNO3, HCOOH and CH3COOH in a 67:20:8:3 mixture, respectively. CaCO3 and NH3 have reduced the potential acidity of the solution by 24% and 13%, respectively. The concentrations of non-sea-salt (nss) SO4(--) and NO3(-) in precipitation on Bermuda are about a factor of three greater than those in remote marine areas of the world. These differences are attributed in part to anthropogenic activities. NH4(+), HCOO-T and CH3COO-T concentrations in Bermuda precipitation more closely resemble remote areas, although there are distinct events where transport from North America is evident. Precipitation associated with air masses from the central Atlantic Ocean is enriched relative to remote areas by about a factor of two in nss SO4(--). This appears to be caused by anthropogenic emissions in North America, Europe and Africa. There are higher volume-weighted average concentrations of nss SO4(--) and NO3(-) in storms on Bermuda associated with the NW airflow sector (from North America) compared to the SE airflow sector. These higher concentrations are in part due to the influence of North America and in part due to the lower amount of precipitation in the NW storms. An analysis of deposition differences between the two sectors confirms that there is at least a factor of two impact of North American anthropogenic activities on nss SO4(--) and NO3(-) in precipitation on Bermuda. (Author's abstract)
W90-02218

NA(+)/CL(-) RATIOS IN RAIN ACROSS THE USA, 1982-1986.
Arkansas Univ., Fayetteville. Dept. of Geology.
G. H. Wagner, and K. F. Steele.
Tellus TELLAL, Vol. 41B, No. 4, p 444-451, September 1989. 2 fig, 3 tab, 30 ref.

Descriptors: *Path of pollutants, *Acid rain, *Chemistry of precipitation, *Rain, *Sodium, *Chlorides, *Air pollution, Seawater, Feldspar, Clays, Aerosols, Powerplants.

Ratios of Na(+)/Cl(-) for annual rain collections for 178 sites in the National Atmospheric Deposition Program/National Trends Network across the USA were compared to the same ratio for sea water. 48% of the sites had ratios which were, within experimental error, the same as sea water. 32% of the sites, all in western states, had Na(+)/Cl(-) ratios greater than sea water. These higher ratios are attributed to Na(+) from feldspar and clay aerosols. The remainder (20%) of the sites, with ratios less than sea water, are mostly in a contiguous area composed of lower Michigan, lower Wisconsin, eastern Illinois, Indiana, Ohio, Kentucky, West Virginia, northern Virginia, Pennsylvania, New York and Massachusetts. This area coincides with the areas of highest SO4(--) and NO3(-) concentrations in rain and is believed to receive inputs of Cl(-) from coal-fired power plants. (Author's abstract)
W90-02219

EFFECTS OF SIMULATED ACID PRECIPITATION ON THE METABOLIC ACTIVITY OF CLADINA STELLARIS.
Ecole Polytechnique, Montreal (Quebec). Section du Genie de l'Environnement.
L. Roy-Arcand, C. E. Delisle, and F. G. Briere.
Canadian Journal of Botany CJBOAW, Vol. 67, No. 6, p 1796-1802, June 1989. 7 fig, 2 tab, 32 ref.

Descriptors: *Acid rain effects, *Lichens, *Water pollution effects, Sulfates, Nitrates, Cladina, Respiration, Simulation, Acidity.

Cladina stellaris (Opiz) Brodo specimens, collected from Kuujjuarapik, Quebec, were kept for 8 weeks in growth chambers and sprayed every day with simulated acid rain solutions to study the effects of rain pH and sulfate to nitrate ratios on the lichen. The acidity of the solution was adjusted to obtain pHs of 2.0, 3.0, 4.0, and 5.0, and the sulfate to nitrate ratios studies were 2:1 and 6:1 microequivalents/liter. Metabolic responses of the lichens to the acidification treatments were assessed by measurements of the number of algal cells, the amount of chlorophyll a, and the basal and resaturation respiration rates. At pHs of 2 and 3, the metabolic activity of young podetial tips of C. stellaris was significantly reduced, whereas the treatments at pH 4 and 5 enhanced growth. Alteration of the sulfate to nitrate ratios in the precipitation did not produce any significant differences in the measured metabolic activity. Cladina stellaris responses to the quantity and quality of acidification were summarized in a set of regression models that emphasized a threshold response to acid precipitation near 3.5; below pH 3.5, metabolism was impaired; whereas above pH 3.5, some metabolic responses were enhanced. (Author's abstract)
W90-02237

EFFECTS OF SIMULATED RAIN ACIDITY ON ECTOMYCORRHIZAE OF RED SPRUCE SEEDLINGS POTTED IN NATURAL SOIL.
North Carolina State Univ. at Raleigh. Dept. of Plant Pathology.
S. Meier, W. P. Robarge, R. I. Bruck, and L. F. Grand.
Environmental Pollution ENPOEK, Vol. 59, No. 4, p 315-324, 1989. 3 tab, 21 ref.

Descriptors: *Soil-water-plant relationships, *Acid rain effects, *Spruce trees, Hydrogen ion concentration, Plant growth, Mycorrhizae, Fungi.

Formation of ectomycorrhizae of red spruce (Picea rubens) grown in natural soil was measured after seedlings were exposed to 25 or 50 applica-

tions of simulated rain of pH 5.5, 3.5 or 2.5. Ectomycorrhizae were quantified as the total number of ectomycorrhizal tips per centimeter, and as the number of ectomycorrhizal tips for each morphotype and for Cenococcum geophilum. Rain solutions were applied to the soil alone, to foliage and stem alone, or to entire potted seedlings. Final soil pH was linearly related to rain solution acidity. Lower base saturation, calcium and zinc content, and higher exchangeable acidity were observed after pH 2.5 treatments if the soil was exposed. Rain solutions and the subsequent changes in soil characteristics did not affect the total numbers of ectomycorrhizal tips. Four morphotypes of ectomycorrhizae observed for these seedlings were unaffected by simulated rain. However, the numbers of ectomycorrhizal tips formed by C. geophilum tended to increase with rain solution acidity after 50 applications. Method of rain deposition did not affect ectomycorrhizae, suggesting both plant and soil mediated responses may favor certain mycobionts. The results of this study indicate that short-term acidic deposition does not induce significant changes in the frequency of ectomycorrhizae, but higher numbers of C. geophilum tips suggest there may be changes in the relative occurrence of specific morphotypes or fungus species. (Author's abstract)
W90-02241

MORPHOLOGY OF CALCITE CRYSTALS IN HARDWATER LAKES.
Akademie der Wissenschaften der DDR, Berlin. Zentralinstitut fuer Elektronenphysik.
For primary bibliographic entry see Field 2H.
W90-02248

MICROBIAL DECOMPOSITION OF PLANT DETRITUS IN LAKES (UNTERSUCHUNGEN ZUM MIKROBIELLEN ABBAU VON PFLANZLICHEM DETRITUS IN SEEN).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 2H.
W90-02254

DISSOLVED AND PARTICULATE TRACE METALS IN A WETLAND OF INTERNATIONAL IMPORTANCE: LAKE MIKRI PRESPA, GREECE.
Athens Univ. (Greece). Inst. of Inorganic and Analytical Chemistry.
For primary bibliographic entry see Field 5B.
W90-02262

HYDROCHEMICAL AND ISOTOPIC STUDY OF THE GROUNDWATER OF THE BOTUCATU AQUIFER IN SAO PAULO STATE (ESTUDO HIDROQUIMICO E ISOTOPICO DAS AGUAS SUBTERRANEAS DO AQUIFERO BOTUCATU NO ESTADO DE SAO PAULO).
Sao Paulo Univ. (Brazil). Inst. de Geociencias.
For primary bibliographic entry see Field 2F.
W90-02273

REDUCTION OF SULFATE IN SEDIMENTS OF THE ELBE ESTUARY (SULFAT-REDUKTION IN SEDIMENTEN DER TIDEELBE).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 2L.
W90-02275

CONCEPT, DESIGN AND EXPERIMENTAL EVALUATION OF A RAMANVLIDAR POLYCHROMATOR FOR SIMULTANEOUS REMOTE MEASUREMENT OF CARBON DIOXIDE AND WATER VAPOR RELATIVE TO OXYGEN (KONZEPTION, AUFBAU UND EXPERIMENTELLE ERPORBUNG EINES POLYCHROMATORS FUER EIN RAMAN-LIDAR ZUR SIMULTANEN FERNMESSUNG VON KOHLENDIOXID UND WASSERDAMPF RELATIV ZU SAUERSTOFF).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 7B.
W90-02283

HYDRODYNAMICS AND HYDROCHEMICAL EVOLUTION OF GYPSUM KARST AQUIFERS: DATA FROM THE EMILIA ROMAGNA REGION.
Istituto Italiano di Speleologia, Bologna (Italy).
For primary bibliographic entry see Field 2F.
W90-02467

STUDY ON ISOTOPES OF KARST WATER AND TRAVERTINE DEPOSITS AT THE HUANGLONG SCENIC SPOT.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 2F.
W90-02469

ABOUT THE HYDROGEOLOGICAL AND HYDROCHEMICAL BEHAVIOUR OF THE KARSTIC AREAS IN THE BASQUE COUNTRY (NORTHERN SPAIN, EUROPE).
Universidad del Pais Vasco, Bilbao (Spain). Dept. of Geodynamic.
For primary bibliographic entry see Field 2F.
W90-02477

RELATIONSHIP BETWEEN KARST AND POROUS AQUIFERS ON THE CHALKIDIKI PENINSULA, GREECE.
Muenster Univ. (Germany, F.R.). Dept. of Geology and Paleontology.
For primary bibliographic entry see Field 2F.
W90-02479

ANALYSIS OF TIME-DEPENDENT FACTORS OF BOSSEA KARSTIC SYSTEM (MARITIME ALPS--ITALY).
Politecnico di Torino (Italy). Dipt. di Georisorse e Territorio.
For primary bibliographic entry see Field 2F.
W90-02481

ANHYDRITE-DOLOMITE FORMATION IN THE UPPER VALLEY OF THE RIVER SECCHIA: KARST HYDROGEOLOGY.
Modena Univ. (Italy). Ist. di Geologia.
For primary bibliographic entry see Field 2F.
W90-02484

SEMI-COVERED KARST AQUIFERS IN THE OPHIOLITE BELT OF YUGOSLAV DINARIDES.
Belgrade Univ. (Yugoslavia). Faculty of Mining and Geology.
For primary bibliographic entry see Field 2F.
W90-02485

HYDROLOGIC CONNECTION BETWEEN SPRING WATER AND THE EVAPORITE OF THE LOWER ST. LOUIS LIMESTONE, KARST MITCHELL PLAIN OF SOUTHERN INDIANA.
Indiana Univ. at Bloomington. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02491

2L. Estuaries

EFFECT OF WIND ON THE VERTICAL CIRCULATION AND STRATIFICATION IN THE VOLKERAK ESTUARY.
Miami Univ., FL. Inst. of Marine and Atmospheric Sciences.
J. van de Kreeke, and K. Robaczewska.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 3, p 239-253, June 1989. 11 fig, 5 tab, 10 ref, 2 append.

Descriptors: *Estuaries, *Water circulation, *The Netherlands, *Water currents, *Saline-freshwater interfaces, *Stratification, *Wind-driven currents, Density stratification, Mathematical equations, Vertical circulation, Turbulent flow, Tidal currents.

In the partially mixed part of the Volkerak Estuary current speed and salt concentration were measured at several stations for periods of 13 hours on August 16 and 17, 1977. The freshwater discharge on those days and during the preceding six months was kept constant at a rate of 50 cu m/s. A similar set of measurements was carried out on March 18, 1980 with a constant freshwater discharge of 100 cu m/s. The vertical circulation and stratification were examined in terms of the external forcings, freshwater discharge and wind, with special emphasis on wind. The effect of wind and longitudinal density gradients on the vertical circulation and stratification in the schematized channel was investigated using a simplified form of the two-dimensional conservation of momentum and salt equations. Using observed values along the axis of the estuary a scaling analysis showed that in the two-dimensional conservation of momentum equation the longitudinal pressure gradient and horizontal turbulent shear were the dominant terms, closely followed by the tidal stress. In the conservation of salt equation, the dominant terms were those associated with advective fluxes resulting from the horizontal and vertical tidal mean velocities, a horizontal flux associated with tidal variations in the longitudinal velocity and salt concentration and the vertical turbulent flux. Comparing calculated and observed vertical circulation and stratification it is shown that wind mixing significantly increased the vertical exchange of momentum, thereby reducing the density-driven vertical circulation (gravitational circulation) and stratification. At the same time, through the wind surface stress, wind generated its own vertical circulation and, therefore, stratification. It was concluded that on the days of the measurements wind was as important as the longitudinal salt concentration gradient in forcing vertical circulation and stratification. (Author's abstract)
W90-01961

MINOR AND MAJOR ELEMENTS IN SUSPENDED MATTER IN THE RHINE AND MEUSE RIVERS AND ESTUARY.
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W90-01962

IN SITU FLUCTUATIONS OF OXYGEN AND SULPHIDE IN MARINE MICROBIAL SEDIMENT ECOSYSTEMS.
Groningen Rijksuniversiteit (Netherlands). Dept. of Microbiology.
R. De Wit, H. M. Jonkers, F. P. van den Ende, and H. van Gemerden.
Netherlands Journal of Sea Research NJSRBA, Vol 23, No. 3, p 271-281, June 1989. 9 fig, 1 tab, 32 ref.

Descriptors: *Cyanophyta, *Sulfur bacteria, *The Netherlands, *Oxygen requirements, *Sulfides, Vertical distribution, Microcoleus, Thiocapsa, Diurnal distribution, Sulfur bacteria, Seasonal variation.

Laminated microbial ecosystems (microbial mats) on the island of Schiermonnikoog (The Netherlands) were studied with respect to variation in oxygen and sulfide profiles, depth distributions of photopigments and viable number and cell volume of purple sulfur bacteria. Cyanobacteria occurred in the top 2 mm, the dominant species being Microcoleus chthonoplastes. The blooming of purple sulfur bacteria below the cyanobacterial layer was observed in autumn, the dominant species being the immotile Thiocapsa roseopersicina. Cell volume of this species is indicative of its growth rate. In situ measurements showed strong diel fluctuations in oxygen and sulfide profiles. Frequently, cyanobacteria and purple sulfur bacteria were exposed to oxygen during the day, and to anoxic conditions at night. Sulfide sometimes reached the layer of the cyanobacteria. The cyanobacteria and the purple sulfur bacteria are both very well adapted to these diel fluctuations. In addition, strong seasonal variations were observed, whereas short-term fluctuations of oxygen occurred due to changing light-climate and rainfall. (Author's abstract)

W90-01963

MICROBIAL GROWTH IN TURBULENT SUSPENSION AND ITS RELATION TO MARINE AGGREGATE FORMATION.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Biological Sciences Branch.
D. K. Muschenheim, P. E. Kepkay, and K. Kranck.
Netherlands Journal of Sea Research NJSRBA, Vol 23, No. 3, p 283-292, June 1989. 8 fig, 1 tab, 49 ref.

Descriptors: *Microbiological studies, *Microorganisms, *Bacteria, Organic carbon, Aggregates, Flocculation, Glacial till, Growth, Respiration.

Microbial growth and respiration responses to seston of differing organic composition revealed two different mechanisms of marine aggregate formation: an almost immediate physicochemical aggregation of fine (<8 microm) particles and a longer-term (48 hrs) production of large, robust aggregates, mediated by bacterial activity. Suspensions of fine Spartina alterniflora fragments and a glacial till from Nova Scotia were used to stimulate bacterial and protozoan growth maintained in turbulent suspension. Under high (6 to 11 mg/cu dm) DOC concentrations bacterial responses were rapid and, after 48 hrs, resulted in large, robust flocculated aggregates. With only the till in suspension, DOC levels were low (<3 mg/cu dm) yet the bacterial response was still rapid. Initial flocculation due to physical factors was evident in the till-only experiment and was either masked or not important in the high DOC experiments. Bacterial respiration per cell was 2 to 3 times as high under low DOC conditions as under high DOC and initial bacterial attachment to particle surfaces was significantly higher. Significant aggregate formation occurred after 48 hrs and appeared to be due to relict exudates from attached bacteria, in spite of low numbers of attached bacteria at the time of flocculation. (Author's abstract)
W90-01964

EARLY DIAGENESIS OF LEAD IN LAURENTIAN TROUGH SEDIMENTS.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
For primary bibliographic entry see Field 2K.
W90-01977

NUMERICAL ANALYSIS OF THE RESONANCE POSSIBILITIES OF A HARBOR BASIN OF VARIABLE DEPTH (UNE ANALYSE NUMERIQUE DES POSSIBILITIES DE RESONANCE D'UN BASSIN PORTUAIRE DE PROFONDEUR VARIABLE).
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-01981

COMPARISON OF UNIVARIATE AND MULTIVARIATE ASPECTS OF ESTUARINE MEIOBENTHIC COMMUNITY STRUCTURE.
Marine Biological Association of the United Kingdom, Plymouth (England).
M. C. Austen, and R. M. Warwick.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 1, p 23-42, Jul 1989. 9 fig, 3 tab, 42 ref, append.

Descriptors: *Statistics, *Estuarine environment, *Benthos, *Distribution patterns, *Species composition, Nematodes, Copepods, Statistical methods, Comparison studies.

In a survey of ten sites in the Tamar estuary in January 1984, spatial variability in the species composition and structure of nematode and copepod species assemblages was greater between sites over a range of 1-3 km than between replicates at the same site. Two aspects of meiofauna community structure were studied: (1) the multivariate information: the identities of the species or nematode feeding types are retained and used integrally with data on abundances during the comparison of assemblages using multivariate analyses (multidimensional scaling ordination (MDS)) and (2) the univariate information: taxonomic identity is not retained during comparisons of assemblage structure; data analyzed includes numerical abundances, species counts and diversity. Multivariate aspects of species assemblage structure were closely correlated with salinity for both copepods and nematodes. For nematode assemblages sediment disturbance may also have been important and other unidentified factors have clear secondary effects on multivariate copepod assemblage structure. Univariate aspects of nematode assemblage structure did not appear to be correlated with the salinity gradient in the Tamar, sites at the mouth and head of the estuary had a more even nematode species distribution than those in the middle reaches. Nematode univariate assemblage structure may have been more strongly influenced by sediment disturbance caused by hydrographic processes, macrofauna, food resource availability or some combination of all three. Copepod abundances and species numbers were variable but assemblages became more dominated and less diverse with increasing distance away from the mouth of the estuary. Data from 1984 were compared with data from 1982 collected at three of the sites. Persistence of assemblage structure varied from site to site and according to the attribute of community structure under consideration. (Author's abstract)
W90-01985

TRACE METAL DISTRIBUTION IN SEDIMENTS AND BENTHIC FAUNA OF HAIFA BAY, ISRAEL.
Israel Oceanographic and Limnological Research Ltd., Haifa.
For primary bibliographic entry see Field 5B.
W90-01986

CHEMICAL SPECIATION OF DISSOLVED NICKEL, COPPER, VANADIUM AND IRON IN LIVERPOOL BAY, IRISH SEA.
Liverpool Univ. (England). Dept. of Oceanography.
M. Nimmo, C. M. G. van den Berg, and J. Brown.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 1, p 57-74, Jul 1989. 5 fig, 6 tab, 36 ref.

Descriptors: *Water pollution sources, *Nickel, *Copper, *Vanadium, *Iron, *Seawater, *Laboratory methods, Chemical speciation, Water pollution sources, Chelation, Pollutant identification.

CSV (cathodic stripping voltammetry) was used to determine dissolved nickel, copper, vanadium and iron in seawater samples collected from Liverpool Bay (Irish Sea). It is shown that the concentrations of the free metal ion and of the metal organic complexes can be calculated from the CSV-labile and total dissolved metal concentrations. The labile fraction consists of the inorganically complexed metal ions, and a certain proportion of the natural organic-metal complexes which depends on the relative stability of the metal complexes formed with the added chelator and with the natural organic ligands. Total dissolved metal concentrations were obtained after UV-photolysis of acidified samples. Results from two surveys, carried out during May and September 1985, clearly identified the River Mersey as being a significant contributor of both nickel and copper to Liverpool Bay. The dumping of sewage sludge produced elevated localized concentrations for colloidal nickel. Considerable proportions of nickel (31-41%) were found to occur as stable organic compounds, whereas almost all copper (98-99%) occurred in less stable organic complexes. A smaller proportion of iron (18%) was found to be bound by dissolved organic material. Organic complexation was generally greater in September than in May. The absence of a relationship between organic complexation and concentration of organic fluorescent material suggests that this material is not a major component of the organic metal complexing material in shelf waters. (Author's abstract)
W90-01987

LITTER PRODUCTION AND TURNOVER OF THE MANGROVE KANDELIA CANDEL (L.) DRUCE IN A HONG KONG TIDAL SHRIMP POND.
Hong Kong Univ. Dept. of Zoology.
S. Y. Lee.
Estuarine, Coastal and Shelf Science ECSSD3, Vol 29, No. 1, p 75-87, Jul 1989. 3 fig, 5 tab, 40 ref.

Descriptors: *Mangrove swamps, *Aquaculture, *Shrimp, *Hong Kong, Productivity, Litter, Cycling nutrients, Tidewater.

Production and turnover of Kandelia candel litter were studied for 2 years in a tidal shrimp pond (10 ha) at the Mai Po Marshes, northwest Hong Kong. Annual litter production averaged 11.070 t/ha (equivalent to 4.880 x 10 to the 7th power kcal/ha), with wood and leaf materials contributing, respectively, 6.15 and 53.94% of the total. The reproductive plus frass component contributed 40.60% of the total production. The mean standing litter biomass recorded during the same period was 9.587 +/-0.556 t/ha (4.968 x 10 to the 7th power kcal/ha), with respective contributions by the three components of 19.07, 42.26 and 28.65%. Residence times (standing biomass/production) of the three components were extraordinarily long, estimated to be, respectively, 980, 300 and 252 days. Stand characteristics of average tree height and diameter were good predictors of litter production while climatic variables, especially rainfall, could be used to predict the production of various litter components. Residence times were related to both inundation frequency and crab (Chiromanthes spp.) consumption. As the Kandelia candel stands were located largely above mean water level, There was little export of litter. The litter produced was predominantly decomposed or consumed by macrofauna in situ, creating a large energy sink which was not coupled to pelagic secondary production. Traditionally, operators of the ponds favor periodic landscape restructuring to create a pattern of numerous cross bunds of K. candel stands separated by deep channels. From the results of this study this management practice is readily explicable, as such a landscape pattern would significantly increase the portion of litter entering the aquatic sector of the pond. Landscape heterogeneity of the tidal ponds probably also affects their attraction to birds, in addition to the regulation of bird populations through food supply. It therefore seems more appropriate to manage the nature reserve as a dynamic, rapidly changing habitat, rather than to 'preserve as it is'. (Shidler-PTT)
W90-01988

SULFATE REDUCTION AND THE FORMATION OF 35S-LABELED FES, FES2, AND S(0) (ELEMENTAL SULFUR) IN COASTAL MARINE SEDIMENTS.
Aarhus Univ. (Denmark). Inst. of Ecology and Genetics.
For primary bibliographic entry see Field 2K.
W90-01993

GAS TRANSPORT FROM METHANE-SATURATED, TIDAL FRESHWATER AND WETLAND SEDIMENTS.
Florida State Univ., Tallahassee. Dept. of Oceanography.
J. P. Chanton, C. S. Martens, and C. A. Kelley.
Limnology and Oceanography LIOCAH, Vol 34, No. 5, p 807-819, Jul 1989. 7 fig, 5 tab, 44 ref.

Descriptors: *Water chemistry, *Geochemistry, *Methane, *Estuarine environment, *Sediments, *Wetlands, Tidewater, North Carolina.

Variations in hydrostatic pressure controlled by diurnal tides triggered ebullition from subtidal freshwater sediments dominated by methanogenesis in the White Oak River estuary, North Carolina. Pulses of gas consisting of 50-80% methane were released when the tidal cycle reached its nadir. In August, site-to-site variations in these fluxes ranged from 60 to 650 ml (39-425 mg) CH4/sq m/day. At a single site, ebullition made up 50% of the total CH4 flux out of the sediments; the remainder was transported across the sediment-water interface by molecular diffusion. The sedimentary gas bubble reservoir varied seasonally between 2.6 and 14.8 L/cu m at two White Oak sites. These quantities represented 10-30% of the total

sedimentary CH4 inventory, the balance of which was dissolved in pore waters. Methane shifted between the two pools with seasonal changes in temperature as bubble methane partial pressure maintained equilibrium with dissolved CH4. Factors controlling the composition of sedimentary gas bubbles were investigated by collecting samples from several environments. These bubbles consisted primarily of CH4, N2, and CO2. The ratio of CH4 to N2 was found to be a useful indicator of mechanisms transporting gases from sediments and was controlled by both the ebullition rate and the presence of rooted emergent macrophytes. (Author's abstract)
W90-01994

EFFECT OF LIGHT AND TEMPERATURE ON DOC EXCRETION BY PHYTOPLANKTON.
Bar-Ilan Univ., Ramat-Gan (Israel). Dept. of Life Sciences.
For primary bibliographic entry see Field 2H.
W90-01995

HIGH LONG-TERM NITRATE UPTAKE BY OYSTER-POND MICROALGAE IN THE PRESENCE OF HIGH AMMONIUM CONCENTRATIONS.
Institut Francais de Recherche pour l'Exploitation de la Mer, Brest.
For primary bibliographic entry see Field 2K.
W90-02001

WATER QUALITY, SEDIMENTS AND THE MACROINVERTEBRATE COMMUNITY OF RESIDENTIAL CANAL ESTATES IN SOUTH-EAST QUEENSLAND, AUSTRALIA: A MULTIVARIATE ANALYSIS.
Queensland Dept. of Environment, Conservation and Tourism, Brisbane (Australia). Div. of Environment.
P. R. Cosser.
Water Research WATRAG, Vol. 23, No. 9, p 1087-1097, 1989. 6 fig, 7 tab, 31 ref.

Descriptors: *Urban hydrology, *Canals, *Australia, *Aquatic environment, *Aquatic animals, Macroinvertebrates, Statistical analysis, Diversity, Dissolved oxygen, Canal design, Aquatic populations, Sulfur, Sediments.

The benthic macroinvertebrate fauna, sediments and water column were monitored at monthly intervals for 13 months at 13 sites in the canal of the Gold Coast, Queensland, Australia. A total of 65 taxa and 4,195 individuals were collected. The 25 taxa selected for statistical analysis comprised 94.8% of the total abundance. Patterns in invertebrate distributions were analyzed by principal component analysis and were related to environmental variables by multiple regression analysis. Two broad benthic community types were defined. One restricted in distribution to dead end locations and characterized by low diversity, low species richness and dominated by Minuspio cirrifera, while the other was distributed in connecting canals and characterized by high species richness and high diversity. The distribution of species, and hence the distribution of community types, was related largely to the quality of the dissolved oxygen environment, which was described by mean dissolved oxygen percentage saturation, standard deviation of saturation and mean percentage sulphur content of sediment. A progressive transition between community types resulting from a deterioration in the quality of the dissolved oxygen environment was evident with increasing distance from source waters in both connecting canals and dead-end locations. Variance in community structures was also explained by sediment type (grain size) to some extent. Sediments became finer with a decrease in the tidal prism and tidal velocity, and were finest at dead-end locations. Results suggest that residential canals should be as short as possible, and dead-ends should be avoided in order to maintain good water quality. (Author's abstract)
W90-02006

MANAGING FRESHWATER INFLOW TO THE SAN FRANCISCO BAY ESTUARY.
Williams (Philip) and Associates, San Francisco, CA.
P. B. Williams.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 285-298, September/October 1989. 6 fig, 28 ref.

Descriptors: *Irrigation effects, *Water quality control, *Water pollution control, *San Francisco Bay, *Estuaries, *Water management, Diversion dams, Environmental effects, Wetlands, Brackish water, Fresh water, Phytoplankton, Anadromous fish.

The water resources of California's Central Valley have been intensively exploited, particularly in the last 50 years, with the construction of large-scale irrigation systems. About half the 35 cu km average annual freshwater inflow to the estuary is now diverted, with up to 85% in dry years. These diversions are now having significant adverse effects on the estuarine ecosystem including substantial declines in the economically significant anadromous fishery. At the time the large dam projects in the watershed were designed, no consideration was given to impacts on the estuary. Due to growing recognition of these impacts, a set of freshwater flow and salinity standards have been proposed. These flow requirements are based on extensive research on the role of freshwater inflow on estuarine hydrodynamics and on the estuarine ecosystem. These requirements have three overlapping goals: (1) Maximizing phytoplankton production--the base of the estuarine food chain; (2) Protecting spawning and migration of anadromous fisheries; and (3) Protecting brackish wetlands. It is estimated that meeting these standards to protect the estuary would require reductions in upstream diversions of about 40 per cent. (Author's abstract)
W90-02048

TIME SERIES ANALYSES OF SUSPENDED SEDIMENT CONCENTRATIONS AT NORTH INLET, SOUTH CAROLINA.
South Carolina Univ., Columbia. Dept. of Geology.
For primary bibliographic entry see Field 2J.
W90-02091

PATTERNS OF SEDIMENT DEPOSITION IN SUBSIDING COASTAL SALT MARSHES, TERREBONNE BAY, LOUISIANA: THE ROLE OF WINTER STORMS.
Louisiana Universities Marine Consortium, Chauvin.
For primary bibliographic entry see Field 2J.
W90-02092

UNDERSTANDING SALT-MARSH ACCRETION, SCOLT HEAD ISLAND, NORFOLK, ENGLAND.
Cambridge Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W90-02093

PATTERNS OF SEDIMENT ACCUMULATION IN THE TIDAL MARSHES OF MAINE.
Maine Univ., Orono. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W90-02094

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. I. 137CS AND 210 PB TECHNIQUES.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2J.
W90-02095

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND II. FELDSPAR MARKER HORIZON TECHNIQUE.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2J.
W90-02096

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. III. A NEW SOIL HORIZON MARKER METHOD FOR MEASURING RECENT ACCRETION.
Louisiana State Univ., Baton Rouge. Nuclear Science Center.
For primary bibliographic entry see Field 2J.
W90-02097

RECENT ACCRETION IN MANGROVE ECOSYSTEMS BASED ON 137 CS AND 210 PB.
University of Southwestern Louisiana, Lafayette. Dept. of Biology.
For primary bibliographic entry see Field 2J.
W90-02098

ACCRETION RATES AND SEDIMENT ACCUMULATION IN RHODE ISLAND SALT MARSHES.
Rhode Island Univ., Narragansett. Graduate School of Oceanography.
For primary bibliographic entry see Field 2J.
W90-02099

RISING WATER LEVELS AND THE FUTURE OF SOUTHEASTERN LOUISIANA SWAMP FORESTS.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
W. H. Conner, and M. Brody.
Estuaries ESTUDO, Vol. 12, No. 4, p 318-323, Dec 1989. 4 fig, 2 tab, 26 ref. Department of Energy contract DE-AC09-76SROO-819.

Descriptors: *Wetlands, *Subsidence, *Louisiana, *Swamps, *Forests, *Sea level, Water level, Model studies, Barataria watershed, Verret watershed, Watersheds, FORFLO model.

An important factor contributing to the deterioration of wetland forests in Louisiana is increasing water levels resulting from eustatic sea-level rise and subsidence. Analysis of long-term water level records from the Barataria and Verret watersheds in southeastern Louisiana indicate an apparent sea level rise of about 1-m/century, mainly the result of subsidence. Permanent study plots were established in cypress-tupelo stands in these two watersheds. The tree, water level, and subsidence data collected in these plots were entered into the U.S. Fish and Wildlife Service's FORFLO bottomland hardwood succession model to determine the long-term effects of rising water levels on forest structure. Analysis were made of 50-100 years for a cypress-tupelo swamp site in each basin and a bottomland hardwood ridge in the Verret watershed. As flooding increased, less flood tolerant species were replaced by cypress-tupelo within 50 years. As flooding continued, the sites start to become nonforested. From the test analysis, the FORFLO model seems to be an excellent tool for predicting long-term changes in the swamp habitat of south Louisiana. (Author's abstract)
W90-02100

ESTUARINE ECOLOGY OF PHENANTHRENE-DEGRADING BACTERIA.
New Hampshire Univ., Durham. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W90-02137

UNUSUAL MARINE EROSION IN SAN DIEGO COUNTY FROM A SINGLE STORM.
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 2J.
W90-02138

ECOLOGY OF UNDERSTORY KELP ENVIRONMENTS: I. EFFECTS OF KELPS ON FLOW AND PARTICLE TRANSPORT NEAR THE BOTTOM.
Skidaway Inst. of Oceanography, Savannah, GA.
J. E. Eckman, D. O. Duggins, and A. T. Sewell.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 129, No. 2, p 173-187, August

22, 1989. 5 fig, 3 tab, 44 ref, append.

Descriptors: *Sediment transport, *Kelps, *Particulate matter, *Suspended solids, *Ecological effects, Deposition, Aquatic animals, Hydrodynamics.

Because of their likely ecological importance, the effects of understory kelps on fluid and particulate transport near the bottom were assessed in waters of the San Juan Archipelago, Washington. Relative to more exposed rocky substrata at identical depths, bottoms beneath kelp canopies were exposed to weak fluid transport and were characterized by greater rates of deposition of particulates. A tracer particle experiment demonstrated that kelps inhibited transport of suspended particles from the overlying water column to the bottom. Thus, the higher rates of particulate deposition beneath kelp canopies probably were caused by longer particle residence times and higher probabilities of particulate redeposition beneath canopies and not by higher rates of particle import. These hydrodynamic effects may play important roles in the ecology of animals that inhabit understory kelp environments. We propose several potential effects of flow modification by kelps on larval recruitment and dispersal and growth of suspension-feeders. (Author's abstract)
W90-02147

BREEDING-SEASON HABITAT USE BY STICKLEBACKS (PISCES: GASTEROSTEIDAE) AT ISLE VERTE, QUEBEC.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Renewable Resources.
For primary bibliographic entry see Field 2H.
W90-02170

CONCENTRATION, OXIDATION STATE, AND PARTICULATE FLUX OF URANIUM IN THE BLACK SEA.
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 2K.
W90-02172

TRANSFORMATIONS OF SULFUR COMPOUNDS IN MARSH-FLAT SEDIMENTS.
State Univ. of New York at Stony Brook. Marine Sciences Research Center.
K. T. Swider, and J. E. Mackin.
Geochimica et Cosmochimica GCACAK, Vol. 53, No. 9, p 2311-2323, September 1989. 16 fig, 2 tab, 79 ref. ACSPRF grant 15887-G2 and NSF grant OCE-8711505.

Descriptors: *Salt marshes, *Mud flats, *Intertidal areas, *Sediments, *Interstitial water, *Geochemistry, *Sulfur cycle, *Iron, Sulfides, Hydrogen sulfide, Sulfates, Pyrite, Flax Pond, Long Island, New York.

Measurements were made in mud-flat sediments from Flax Pond salt marsh to characterize the rates and mechanisms of sulfur cycling in an organic-rich coastal marine environment. Approximately 13 mmol/sq m of reduced sulfur are generated annually in the mud flat and the dominant solid-phase product is pyrite. Ion activity products involving dissolved Fe and sulfide species indicate approximate saturation with respect to metastable iron sulfide phases, showing that pyrite is not likely to be the first-formed Fe-bearing sulfide. Comparison of H2S vs. sulfate relationships in anoxic incubation experiments with those occurring in the undisturbed sediment permits evaluation of possible mechanisms involved in the transformation of metastable iron monosulfides to pyrite. Oxidants (e.g. MnO2) that are introduced into the surface sediment, either by animal activity or physical events, are apparently necessary to cause major oxidation of FeS and H2S to pyrite and sulfate. Solid-phase sulfur analyses and net H2S accumulation in sediment pore waters are consistent with major sulfide oxidation, indicating that approximately 95% of the sulfide generated in the mud flat is reoxidized to sulfate and roughly half of this oxidation involves dissolved sulfide. The major factors limiting reduced sulfur burial are physical and biological disturbances and a low abundance of reactive solid-phase iron (2 wt%). (Author's abstract)
W90-02174

MOVEMENT OF PHOSPHATE IN A CATCHMENT WITH A SHALLOW EPHEMERAL WATER TABLE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia).
For primary bibliographic entry see Field 5B.
W90-02181

DECAY TIMES OF ORGANIC CARBON IN SEDIMENTED DETRITUS IN A MACROTIDAL ESTUARY.
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Dept. of Fisheries and Oceans.
B. T. Hargrave, and G. A. Phillips.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 3, p 271-279, August 24, 1989. 4 fig, 2 tab, 36 ref.

Descriptors: *Estuaries, *Intertidal areas, *Decomposing organic matter, Detritus, Respiration, Oxygen, Carbon dioxide, Chlorophyll a, Seasonal variation, Bay of Fundy, Canada.

Respiration rates of particulate matter, collected in sediment traps placed 1 m above the sediment during tidal cover at an intertidal site on the upper Bay of Fundy, Canada, were calculated from oxygen and carbon dioxide fluxes. Values decreased from 6 microgram C/g dry wt/hr during mid-summer to <0.5 microgram C/g dry wt/hr in winter. Rates were positively correlated with seasonal changes in temperature with a coefficient equivalent to a Q10 of 2 and with chlorophyll a in settled material. The ratio of total organic C in detritus to daily respiration gave first-order decay constants (k) of 2-5/yr during summer and 0.3-1.3/yr during winter. Equivalent 95% decay times (3/k) were 200-500 d and 800-3800 d, respectively. Respiration of labile organic C was calculated from organic C exceeding the seasonal minimum (0.8% dry weight) and chlorophyll a content. Lower decay times (20-40 d) during the summer coincided with low labile organic C:chlorophyll a ratios (30-50) indicative of freshly produced organic matter. (Author's abstract)
W90-02209

GRAZING AND SEDIMENTATION OF ICE ALGAE DURING AND IMMEDIATELY AFTER A BLOOM AT THE ICE-WATER INTERFACE.
Laval Univ., Quebec. Dept. de Biologie.
C. Tremblay, J. A. Runge, and L. Legendre.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 3, p 291-300, August 24, 1989. 7 fig, 4 tab, 52 ref.

Descriptors: *Eutrophication, *Ice-water interfaces, *Algae, *Eutrophication, *Arctic, Polar regions, Sedimentation, Chlorophyll a, Phaeopigments, Hudson Bay, Canada.

Sinking of pigmented particulate matter during and immediately after an ice algal bloom was studied in southeastern Hudson Bay at a 45 m deep station, using consecutive short-term deployments of sediment traps 30 m below the undersurface of the ice. Cell sinking and grazing by herbivores were assessed by measuring the vertical fluxes of chlorophyll a and phaeopigments. There were 2 peaks of cell sedimentation, a minor one during the first half of the bloom (mid-April) and a major one at the end of the bloom (mid-May); both were related to atmospheric warming events. The fluxes of both phaeopigments and fecal pellets (mainly from large herbivores) increased at the end of the bloom as ice algae were released from the ice environment. The total export of ice algae to the benthos (sinking cells + fecal pellets) was estimated to be about 20% of the ice algal production during the measurement period. A large proportion of ice algal production (about 30%) was still suspended in the upper water column at the end of the sampling season. The fate of the remaining 50% is not known, but it is hypothesized that a significant fraction was retained in the pelagic environment. (Author's abstract)
W90-02210

RELATIONSHIPS BETWEEN BACTERIA, PHYTOPLANKTON AND PARTICULATE ORGANIC CARBON IN THE UPPER ST. LAWRENCE ESTUARY.
Institut Maurice-Lamontagne, Mont-Joli (Quebec).
J. Painchaud, and J.-C. Therriault.
Marine Ecology Progress Series MESEDT, Vol. 56, No. 3, p 301-311, August 24, 1989. 3 fig, 5 tab, 60 ref.

Descriptors: *Estuaries, *Aquatic bacteria, *Phytoplankton, *St Lawrence Estuary, *Particulate matter, *Organic carbon, Chlorophyll, Photosynthesis, Salinity.

The relationships between bacterial and phytoplankton variables, and particulate organic carbon (POC), were examined along a longitudinal transect in the St. Lawrence Estuary. Free bacteria, bacterial biomass and heterotrophic activity decreased in a seaward direction, whereas chlorophyll, phytoplankton biomass and photosynthetic activity had minimum values in the mid-estuarine region. Values of POC and attached bacteria were highest at the upper limit of the salinity intrusion, in the zone of maximum turbidity. Free bacteria predominated largely over attached bacteria, which were probably of benthic origin. It is hypothesized that free and attached bacteria formed 2 distinct, independent communities. Correlation analysis showed that, in general, bacterial and phytoplankton variables were highly correlated and that these variables were linked to salinity. The effect of salinity on these correlations was controlled using partial correlation analysis and the results showed that only attached bacteria of the maximum turbidity zone were significantly correlated with chlorophyll and POC concentrations. Elsewhere, phytoplankton and bacterial variables were not correlated. Careful examination revealed that bacterial biomass largely exceeded that of phytoplankton everywhere, except at the most seaward station, where coastal rather than estuarine conditions prevailed. This study thus suggests that phytoplankton and POC did not to a large extent determine bacterial distribution in the Upper St. Lawrence Estuary and that bacteria may have a relatively important trophic role in this system. (Author's abstract)
W90-02211

DETERMINATION OF MOLYBDENUM IN ESTUARINE WATERS USING CATHODIC STRIPPING VOLTAMMETRY.
Liverpool Univ. (England). Oceanography Lab.
For primary bibliographic entry see Field 7B.
W90-02212

STEROID ALCOHOLS AND KETONES IN COASTAL WATERS OF THE WESTERN MEDITERRANEAN: SOURCES AND SEASONAL VARIABILITY.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
J. M. Bayona, A. Farran, and J. Albaiges.
Marine Chemistry MRCHBD, Vol. 27, No. 1-2, p 79-104, September 1989. 6 fig, 7 tab, 73 ref, append.

Descriptors: *Biochemistry, *Biogeochemistry, *Steroids, *Seawater, *Mediterranean Sea, *Phytoplankton, Biomarkers, Algae, Dinoflagellates, Particulate organic matter, Coastal waters, Seasonal variation, Fecal pollution.

A total of 36 sterols (stenols and stanols) and 17 sterones (stenones and stanones) were identified in the particulate organic matter (POM) of surface seawater from the western Mediterranean in the vicinity of the Ebro river mouth. Concentrations of particulate sterols ranged from 0.6-4.8 microgram/l in the delta bays and from 0.07-1.1 microgram/l in the open sea transects. Sterones were present at one order of magnitude lower. Both the concentrations and the compositions of steroidal components were seasonally dependent, reflecting changes in the phytoplanktonic population, in the

sense that diatom biomarkers (delta-5,delta-5,22 and delta-5,24(28)-stenols, and delta-4-stenones) were the major components during marine fertile periods (spring and fall), whereas dinoflagellate markers (4-alpha-methylstanols and 4-alpha-methylstanones) predominated during the lowest productivity periods (summer and winter). Based on spectral data 4-alpha-methylcholest-7-en-3-beta-ol, 4-alpha,23,24-trimethylcholest-7-en-3-beta-ol, 4-alpha-methyl-5-beta(H)-cholestan-3-beta-ol and 24-methylcholesta-4,24(28)-dien-3-one were identified for the first time in seawater particles. Some of these are proposed as biomarkers of the dinoflagellate contribution to POM in seawater. In addition, the occurrence of red algae in the river bays in spring is suggested by steroidal biomarkers (i.e. cholesta-5,24(25)-dien-3-beta-ol). Fecal pollution was detected, according to the 5-beta-steroids distribution, near the Ebro river mouth and Tarragona. (Author's abstract)
W90-02213

HYDROGRAPHIC AND PLANKTONIC VARIABILITY IN THE SARONIKOS GULF.
National Centre for Marine Research, Athens (Greece).
For primary bibliographic entry see Field 5C.
W90-02222

EUTROPHICATION AND RED TIDE IN AEGEAN COASTAL WATERS.
National Centre for Marine Research, Athens (Greece).
For primary bibliographic entry see Field 5C.
W90-02223

MODELLING LIGHT DISTRIBUTION WITHIN THE CANOPY OF THE MARSH GRASS SPARTINA ALTERNIFLORA AS A FUNCTION OF CANOPY BIOMASS AND SOLAR ANGLE.
South Carolina Univ., Columbia. Dept. of Biology.
For primary bibliographic entry see Field 2H.
W90-02227

IMPACT OF INDUSTRIAL AND MINE DRAINAGE WASTES ON THE HEAVY METAL DISTRIBUTION IN THE DRAINAGE BASIN AND ESTUARY OF THE SADO RIVER (PORTUGAL).
Bordeaux-1 Univ., Talence (France). Groupe d'Oceanographie Physicochimique.
For primary bibliographic entry see Field 5B.
W90-02239

TURBIDITY PATTERNS IN THE DELTA WATERS OF SOUTHWEST NETHERLANDS ON THEMATIC MAPPER (TM) AND MULTISPECTRAL SCANNERS (MSS) SATELLITE IMAGES (TROEBLHEIDSPATRONEN IN DE DELTAWATEREN VAN ZW NEDERLAND OP TM EN MSS SATELLIETBEELDEN).
Begeleidingscommissie Remote Sensing, Delft (Netherlands).
For primary bibliographic entry see Field 7B.
W90-02269

REDUCTION OF SULFATE IN SEDIMENTS OF THE ELBE ESTUARY (SULFAT-REDUKTION IN SEDIMENTEN DER TIDEELBE).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
H. Tiedemann, and R. D. Wilken.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-753776/GAR. Price codes: A03 in paper copy, A01 in microfiche. GKSS-87/E/53, 1987. 35p, 14 fig, 5 tab, 46 ref. English summary.

Descriptors: *Elbe River, *Estuaries, *Marine sediments, *Sulfates, West Germany, Isotope tracers, Sulfate reduction, Depth, Temperature.

From autumn 1984 to summer 1985 sulfate reduction rates were measured at three sampling locations in the tidally influenced Elbe river (Oortkaten, Muehlenberger Loch, Neufelder Watt), using the S35 technique. The average water discharge was approximately 750cu m/s. The sulfate reduction rates were measured at different depths (every 2 cm). The reduction was normal at first (depending on the temperature of the sample) in the first two cm; although two zones of higher rates were often found down to a depth of 35 cm. Reduction occurred not only in the temperature range of 15-20 C, but also down to temperatures of 4 C (more than 100 nmol SO4(2-)/cc/day). (Author's abstract)
W90-02275

INVESTIGATIONS OF BIOLOGICAL MEASURES FOR RESTORATION OF OIL POLLUTED TIDAL FLATS (UNTERSUCHUNGEN MIT DEM ZIEL DES VORSCHLAGS BIOLOGISCHER MASSNAHMEN BEI OELVERSCHMUTZUNGEN DER WATTOBERFLAECHE).
Oldenburg Univ. (Germany, F.R.). Inst. fuer Chemie und Biologie des Meeres.
For primary bibliographic entry see Field 5G.
W90-02281

COASTAL POLLUTION--AESTHETICS AND/OR HEALTH.
Coastal Antipollution League, Ltd.
For primary bibliographic entry see Field 5C.
W90-02321

SEWAGE SLUDGE DISPOSAL AT SEA--OPTIONS AND MANAGEMENT.
Ministry of Agriculture, Fisheries and Food, London (England).
For primary bibliographic entry see Field 5E.
W90-02325

TIDAL MODELS.
Technical Univ. of Lisbon (Portugal). Inst. Superior Tecnico.
I. B. Mota Oliveira.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 257-302, 16 fig, 4 ref.

Descriptors: *Oil dispersants, *Dispersants, *Model studies, *Tidal hydraulics, *Tidal models, *Hydraulic models, Tidal currents, Physical models, Tides, Estuaries, Coastal waters, Lagoons, Portugal, Uruguay, Model studies, Mathematical studies.

In both estuaries and coastal shallow zones, the tide, through its associated currents, is a dominant factor in the maintenance of natural channels, in the situation of artificial canals, in their navigability, and sometimes, in the safety conditions of moored ships. Very often tidal models concern a large area because it reproduces the whole area of an estuary and the maritime zone adjacent to its entrance. Even when it only reproduces a limited section of the estuary, or a small portion of the coastal zone, the area occupied in the laboratory is very important, and so the choice of the horizontal linear scale becomes very often the first problem to be solved according to the space available, that is to say, the economics of the physical model. This aspect is peculiar to the tidal model, but in other aspects the tidal model has a lot in common with other physical models (i.e., those of rivers with fixed or movable beds). The laws that govern simulation of the tidal flow in a physical model (with a fixed or a movable bed) are not very different from those concerning the steady flow. With recent advances in tidal physical models, greater attention is given to the processes of their automatic control (specifically, tide generation, and data acquisition and analysis). Case studies of tidal models are presented for Portugal and Uruguay. (See also W90-02358) (Lantz-PTT)
W90-02364

EFFICIENT PROGRAM FOR SIMULTANEOUS PREDICTION OF HURRICANE STORM TIDE, BEACH EROSION, AND WAVE EFFECTS.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
S. J. Siah, B. E. Herchenroder, and C. D. Miller.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 288-301, 4 fig, 15 ref.

Descriptors: *Flood forecasting, *Storm tides, *Beach erosion, *Wave action, Simulation analysis, Wave height, Wave pile-up, Wave runup, Physical properties, Storms, Storm surges, Floods.

A series of stand-alone programs simulating the storm-related effects of storm tide, wave heights, wave setup, beach erosion, and wave runup were combined into a single program with the objective of producing a reasonably accurate operational forecast tool. Preliminary results indicate that there is a sensitive interplay and dependency among the various physical phenomena. This is especially true of wave runup which responds to subtle changes in storm tide, bottom profiles, and incident wave conditions. It is evident that the magnitude and duration of the storm impacts are site-specific and storm-specific and that further exploration of these relationships will have to be undertaken before general rules can be established. Storm surge calculations, in a strict sense, apply to the open coast only; the modification of the surge as it propagates overland or within embayments (intracoastal waterways, rivers, bays, etc.) is not considered. It is possible, though, to incorporate a spatial growth or decay factor to artificially accommodate an inland enhancement or attenuation of the storm tide. (See also W90-02368) (Fish-PTT)
W90-02404

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3C. Use Of Water Of Impaired Quality

YIELD AND PLANT NUTRIENT CONTENT OF VEGETABLES TRICKLE-IRRIGATED WITH MUNICIPAL WASTEWATER.
Agriculture Canada, Summerland (British Columbia). Research Station.
For primary bibliographic entry see Field 5E.
W90-02230

INNOVATION AND ENVIRONMENTAL PROTECTION IN PLANTS OF THE TEXTILE FINISHING INDUSTRY: RESULTS OF A POSTAL INQUIRY (INNOVATION UND UMWELTSCHUTZ IN BETRIEBEND DER TEXTILVEREDLUNGSINDUSTRIE: ERGEBNISSE EINER POSTALISCHEN BEFRAGUNG).
For primary bibliographic entry see Field 6D.
W90-02284

3D. Conservation In Domestic and Municipal Use

DEVELOPMENT OF A RESIDENTIAL WATER CONSERVATION DEMONSTRATION MODULE.
Kansas Water Resources Research Inst., Manhattan.
J. K. Koelliker, and B. M. McEnroe.
Kansas Water Resources Research Institute Contribution No. 249, September 1985. 21p, 2 fig, 7 tab, 8 ref, diskette. Kansas Water Resources Research Institute Project G907-22.

Descriptors: *Water conservation, *Domestic water, *Computer programs, Costs, Economic aspects, Water demand, Water use, Kansas.

Residential water conservation is becoming increasingly important as water demands and costs increase, and existing supplies become less adequate. Conservation should be viewed as an alternative to developing new water supplies since

water conserved from existing supplies can be made available to new users. A microcomputer program was written that analyzes a person's water habits and provides quantitative information on potential water savings and the corresponding financial benefits. The program asks the user questions about his source of water, type of energy to heat water, marginal cost of water and energy, and water use habits. From this information the program computes the amount of water used per year for various functions, compares these with national average values, and then reports the potential annual savings of water and dollars. The program provides a printed copy of the results which contains recommendations for conservation and the estimated annual dollar savings for each recommendation. Twenty-five people completed the program to check the program's integrity and to generate a set of data that could be used to determine the potential water savings suggested by the program. Average estimated potential water conservation was 24% of total water and 32% of hot water if all recommendations were followed. Estimated annual dollar savings from less energy use were $70, $21, and $27 per person with water heated by electricity, natural gas, and propane, respectively. This program represents a first step in water conservation. It provides incentives to modify water use habits to effect water savings. An additional educational microcomputer program should be developed to provide information on cost-effective physical changes within the residence that can reduce water use to well below the national average. (Lantz-PTT)
W90-02309

3F. Conservation In Agriculture

STRATEGIES FOR AGRICULTURE.
Resources for the Future, Inc., Washington, DC. Energy and Natural Resources Div.
For primary bibliographic entry see Field 6D.
W90-02133

EXPONENTIAL POLYNOMIAL MODEL (EPM) OF YIELD FORECASTING FOR SPRING WHEAT BASED ON METEOROLOGICAL FACTORS AND PHENOPHASE.
Akademia Rolnicza, Wroclaw (Poland). Faculty of Land Reclamation and Improvement.
For primary bibliographic entry see Field 2B.
W90-02226

EFFECT OF IRRIGATION ON SALT AND SODIUM CONTENT OF SALT AFFECTED SOILS IN CENTRAL NEBRASKA.
Nebraska Univ., Lincoln. Dept. of Agronomy.
D. T. Lewis, and K. Z. Al Janabi.
Communications in Soil Science and Plant Analysis CSOSA2, Vol 20, No. 11-12, p 1219-1229, July 1989. 3 fig, 2 tab, 16 ref.

Descriptors: *Irrigation effects, *Saline soils, *Sodium, *Soil properties, Soil horizons, Water quality, Platte River floodplain, Nebraska, Pastures, Cultivated lands, Leaching.

The effect of irrigation water of good quality on the salt and sodium content of some Halaquepts on the floodplain of the Platte River in Central Nebraska was determined. The study compared salts and sodium concentrations in A and B horizons of adjacent soils in three fields within a single delineation of a map unit. Land uses were long term irrigation, recent introduction to irrigation, and permanent pasture that had never been cultivated or irrigated. The presence of a salt crust on the surface of the field that had been irrigated for some time led the farm operator to believe that irrigation was increasing salt problems within the field. The objective of the study was to determine whether or not this was true. Salt content, sodium absorption ratio, and exchangeable sodium values were not greater in the irrigated field than in the permanent pasture. Salt contents of A horizons were the same in all fields, whereas B horizon salt content tended to be lower where both long and short term irrigation had been practiced. Sodium absorption ratios and exchangeable sodium percentages followed the same pattern as that of soluble salts. Irrigation with water of good quality appeared to be decreasing both salt and sodium content of these soils. (Author's abstract)
W90-02228

WATER USE AND WATER-USE EFFICIENCY OF PERENNIAL RYEGRASS SWARDS AS AFFECTED BY THE HEIGHT AND FREQUENCY OF CUTTING AND SEED RATE.
Institute of Terrestrial Ecology, Huntingdon (England). Monks Wood Experimental Station.
R. Cox, T. W. Parr, and R. A. Plant.
Grass and Forage Science GFSCDW, Vol 43, No. 1, p 97-104, March 1988. 4 fig, 5 tab, 23 ref.

Descriptors: *Water use efficiency, *Crop yield, *Water use, *Soil water, Grasses, Evapotranspiration, Lawns, Forages, Biomass, Water conservation.

The effects of cutting height (20 and 44 mm), frequency (once every 2 weeks April-September inclusive and twice a year) and seed rate 250 and 20 kg/ha) on the water use and herbage yield of perennial ryegrass swards, for 3 years after sowing, were compared. Frequent cutting and a low cutting height reduced water use in the first year only. In later years infrequent cutting led to higher yields and higher water-use efficiencies, but did not affect total water use or the shape of the soil water profile. Seed rate influenced sward composition and the pattern of water use, but not total water use. The swards from the low seed rate had a lower stubble biomass and tiller density, and extracted relatively more water at depths of 75 and 85 cm and less at depths of 15 and 35 cm, than the swards derived from the high seed rate. The ratio of actual:potential evapotranspiration was reduced as the soil water deficit increased and was lowest in the summer after a dry spring. Cutting height and frequency during summer were shown not to be effective methods of either conserving water or manipulating the effective rooting depth of an established sward. (Author's abstract)
W90-02229

EFFECTS OF AGRICULTURAL WATER TABLE MANAGEMENT ON DRAINAGE WATER QUALITY.
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
For primary bibliographic entry see Field 5G.
W90-02311

GROUND WATER FOR SMALL SCALE IRRIGATION IN MINIKARSTIC LIMESTONE TERRAIN IN SAURASHTRA AREA IN WESTERN INDIA.
Ground Water Inst., Poona (India).
For primary bibliographic entry see Field 2F.
W90-02496

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

FACTORS AFFECTING THE DISTRIBUTION AND ABUNDANCE OF AQUATIC PLANTS IN A NAVIGABLE LOWLAND RIVER: THE RIVER NENE, ENGLAND.
Leicester Univ. (England). Dept. of Zoology.
S. J. Brierley, D. M. Harper, and P. J. Barham.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 263-274, September/October 1989. 7 fig, 1 tab, 28 ref.

Descriptors: *Aquatic weed control, *Aquatic weeds, *Aquatic plants, *England, *Navigable rivers, Navigation obstructions, Dredging, Populations, Habitats, Scour, Distribution patterns, Population density.

Investigations were conducted into the causes of a decline in the abundance of rooted aquatic plants in the River Nene. These plants were formerly troublesome to navigation and obstructed summer storm flows and were regularly cut by Anglian Water until 1976. After 1977 plant growth caused only localized problems so cutting ceased. An investigation into the causes of the plant decline was initiated in order to provide predictions for management decisions about the future use of machinery and personnel. Plant abundance during July and August 1984 was measured from the bankside in 200 m lengths of the river at 35 sites, 23 of these on the navigable channel and 12 on the backchannels. Twenty-eight emergent and floating-leaved species occurred, with thirteen submerged species. There was no longitudinal pattern in species richness for either submerged or emergents. Cluster analyses of abundance estimates of submerged species revealed no pattern. There was no separation into distinctive aquatic plant communities along the length of the river but clustering of submerged plant abundance did separate shallow backchannel sites from those in the main channel and deep backchannel. It was concluded that there was a natural loss of plants by scouring in the abnormally high flows of 1976/77 winter. The regular pattern of maintenance dredging, which had been implemented following water industry reorganization in 1974, was shown to suppress abundance for at least five years after dredging. It was concluded that weedcutting would not be necessary in the future if the policy of dredging continued as at present. Dredging should be carried out as lightly as possible on a regular basis and that further investigations should focus on the timescale of abundance change after dredging and on the effects of management on rare species. (White-Reimer-PTT)
W90-02046

HYDROLOGIC EFFECTS OF THE 1984 THROUGH 1986 L-31 CANAL DRAWDOWNS ON THE NORTHERN TAYLOR SLOUGH BASIN OF EVERGLADES NATIONAL PARK.
Everglades National Park, Homestead, FL. South Florida Research Center.
For primary bibliographic entry see Field 6G.
W90-02305

CLOVER FORK TUNNEL DIVERSION PROJECT, HARLAN, KENTUCKY: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8A.
W90-02306

FLOODPLAIN HARMONY.
For primary bibliographic entry see Field 6F.
W90-02368

CURRENT AND FUTURE DIRECTION OF THE CORPS OF ENGINEERS WATER RESOURCES PROGRAMS.
Corps of Engineers, Washington, DC.
For primary bibliographic entry see Field 6F.
W90-02369

SOIL CONSERVATION SERVICE AND FLOODPLAIN MANAGEMENT: A LOOK AHEAD.
Soil Conservation Service, Washington, DC.
G. S. Bridge.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 10-16.

Descriptors: *Flood plain management, *Flood control, *Erosion control, *Water resources development, *Flood damage, *Soil conservation, Economic aspects, Interagency cooperation, Storm runoff, Engineering, Watershed management, Hydrology, Hydraulics, Land development.

Ways are needed of identifying and implementing cost-effective solutions to the continually rising

flood damages occurring throughout the nation. The Soil Conservation Service (SCS) was established in 1935 and became the technical or engineering arm of the U.S. Department of Agriculture (USDA). Water resources and flood plain management activities came with the realization that flood runoff could be reduced by dealing with the water where it falls on the land rather than where it runs off downstream. The SCS has become involved in watershed protection, flood prevention, erosion control, flood control, and has cooperated with other federal, state, and local agencies to train specialists in hydrology and hydraulics. Some obvious concerns when looking at the SCS's ability to participate in flood plain management are appropriated funds, development on flood-prone lands, and changing economic and environmental conditions. Priority will continue to be given to studies that identify areas where flood damages are increasing and that focus on cost-effective solutions to reduce damages, including structural and nonstructural alternatives. The SCS plans to shift more resources into their Flood Plain Management Studies, geared to help local, upstream communities identify their flood hazards and to evaluate cost-effective solutions. The SCS also plans to provide technical assistance to rural communities in storm water management. Efforts must be intensified to work more closely with other agencies to achieve common goals. (See also W90-02368) (Fish-PTT)
W90-02370

ENHANCING AWARENESS OF FLOOD-PRONE AREAS: THE DILEMMA OF TECHNICAL INFORMATION AND KNOWLEDGE HOLDING.
University of West Florida, Pensacola. Dept. of Political Science.
For primary bibliographic entry see Field 6F.
W90-02371

FLOODPLAINS AND NATURAL HAZARD MANAGEMENT: THE DECADE AHEAD.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 6F.
W90-02373

KISSIMMEE RIVER: FLOODPLAIN HARMONY IN RESTORATION.
South Florida Water Management District, West Palm Beach.
J. T. B. Obeysekera, and M. K. Loftin.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 79-86, 4 fig, 4 ref.

Descriptors: *Environmental control, *Environmental policy, *Flood plain management, *Flood routing, *Flood control, Flood damage, Hurricanes, Public policy, Canals, Structural engineering, Habitats, Aesthetics, Field tests, Physical control, Mathematical models, Channeling, Hydraulic gradient, Channel flow, Flood stages, Florida.

Restoration of the Kissimmee River in central Florida is possibly the most ambitious environmental restoration project in the world. This region, as well as most of southern Florida, experienced extensive flood damages during the first half of this century as a result of hurricane events. Public pressures to prevent recurrence of these damages led to the construction of a major federal flood control project, consisting of improved outlets for the Upper Basin lakes and an interconnecting canal system. There have been over ten years of restoration efforts continuing at this time. The primary goal of restoration is to restore environmental values including both habitat and aesthetic values while maintaining the necessary flood control capability of the current system. A major field experiment, the Phase I Demonstration Project, was constructed in 1984 and 1985. Field tests and physical and mathematical modeling are being used to further understand the ramifications of dechannelization. The most difficult feature to restore is the hydraulic gradient relative to flow and stage. (See also W90-02368) (Fish-PTT)
W90-02376

STREAM RENOVATION: A NEW APPROACH TO AGRICULTURAL FLOOD DAMAGE REDUCTION.
Tennessee Valley Authority, Nashville.
D. L. Porter.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 87-93.

Descriptors: *Stream improvement, *Water resources development, *Flood plain management, *Interagency cooperation, *Watershed management, *Soil conservation, Erosion control, Bottomland, Drainage engineering, Jurisdiction, Environmental policy, Long-term planning, Land use, Tennessee, Governmental interrelations.

In 1976, local officials and area landowners requested Tennessee Valley Authority (TVA) and Soil Conservation Service (SCS) assistance in solving stream blockage and impaired drainage problems affecting the bottomland areas of the Tennessee River watershed portion of west Tennessee. The West Eight County Association of Soil Conservation Districts was formed in 1978 to develop and implement comprehensive and coordinated programs for controlling excessive erosion of upland soils and renovating sediment and debris clogged stream channels. The West Eight program is unique for several reasons. First and foremost, it is a cooperative effort between several federal, state, and local agencies, area landowners, and conservation and environmental groups. The various projects are developed utilizing complete hydrologic units rather than the old piece-meal approach of using governmental jurisdictions as project boundaries. Alternative stream renovation methods, such as those used in the West Eight program, involve environmental tradeoffs. Most of these tradeoffs should be acceptable to landowners and conservationists alike, if long-term solutions to stream blockage and impaired drainage problems can be implemented without jeopardizing the stream's aquatic resources or recreational value while improving its flood-carrying capability. The real key to solving these problems is a willingness on the part of the landowners, government agencies, and conservation and environmental groups to work together in an honest effort to develop and implement solutions acceptable to all parties. (See also W90-02368) (Fish-PTT)
W90-02377

TURNING A DITCH BACK INTO A CREEK.
Center for Energy and Environment Research, San Juan, PR.
M. J. Sandler, and T. R. Bacon.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 94-99, 2 fig.

Descriptors: *Stream improvement, *Water resources development, *Public participation, *Water quality management, *Flood plain management, Natural streams, Stream gradient, Streambeds, Recreation demand, Hydraulic properties, Culverts, Grading, Channel improvement, Decision making, Interagency cooperation, Alaska.

Up until the late 1950s, the South Anchorage, Alaska, reach of Little Campbell Creek was a natural meandering stream in a forested rural area. Since then, the creek has been moved to make more room for a playground area and a trailer court, resulting in a creek that took 50% longer in length to drop the same eight feet, and winter episodes of extensive icing and overflow rendered large school playground areas unusable, blocked roads, and threatened homes. In 1985, the Anchorage mayor initiated public action to promote water quality and flood plain improvements through the establishment of a multi-department Water Quality Council, choosing this reach of Little Campbell Creek to be their inaugural stream restoration project. An appointed advisory committee met weekly to learn about the history and hydraulics of the creek, review the analyses and choose from among the alternatives for heat tracing of culverts, regrading, channel widening, and stream realignment. After much consideration, the citizen committee recommended the alternative of rerouting the channel of the creek through the trailer park and then developing it as a badly needed neighborhood park. Several key elements of the project were critical to its success both on the technical and public perception levels, including input from many sources, a commonly-accepted decision-making process, public involvement and education, regulatory agency assistance, funding from municipal agencies. Unforeseen project benefits resulted from real involvement of the citizen review committee and the public. (See also W90-02368) (Fish-PTT)
W90-02378

POST-FLOOD DAMAGE ASSESSMENT AND REDUCING THE COST OF DISASTER.
Federal Emergency Management Agency, Washington, DC.
For primary bibliographic entry see Field 6B.
W90-02387

REGIONAL FLOOD CONTROL PROJECTS IN HARRIS COUNTY, TEXAS.
Harris County Flood Control District, Houston, TX.
S. D. Fitzgerald, and M. J. Talbott.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 214-222, 2 fig.

Descriptors: *Flood plain management, *Flood control, *Regional development, *Weirs, *Flood basins, Inlets, Structural engineering, Hydrologic aspects, Hydraulic models, Channels, Detention reservoirs, Financing, Model studies, Land use, Texas.

Six regional flood control projects have been developed in Harris County, Texas, addressing hydrological and hydraulic analysis, channel and detention basin sizing, financing, and implementation. A physical model study of a side-channel weir is being conducted to determine the necessary weir characteristics for regional basin inlet structures designed to minimize the detention volume and land surface required. Two important aspects considered in developing the regional plans were project phasing and financing. The regional flood control project provides the opportunity to periodically review the performance of the channels and detention basins and to make modifications, if necessary. (See also W90-02368) (Fish-PTT)
W90-02395

FROM HARM'S WAY: FLOOD-HAZARD MITIGATION IN TULSA, OKLAHOMA.
Tulsa, OK.
For primary bibliographic entry see Field 6F.
W90-02396

USING DRAINAGE ORGANIZATIONS AS TOTAL RESOURCE MANAGEMENT TOOLS.
For primary bibliographic entry see Field 6F.
W90-02397

CRISFIELD, MARYLAND FLOOD ALLEVIATION AND TIDAL DIKE STUDY.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
For primary bibliographic entry see Field 6F.
W90-02403

MAPPING INNOVATIONS FOR FLOODPLAIN MANAGEMENT AND ENGINEERING.
Dewberry and Davis, Fairfax, VA.
For primary bibliographic entry see Field 7C.
W90-02406

APPLICATION OF FLOODPLAIN MANAGEMENT BY LOCAL GOVERNMENT USING GIS TECHNOLOGY.
Pinellas Park Water Management District, FL.
For primary bibliographic entry see Field 7C.
W90-02408

APPLICATION OF FREQUENCY AND RISK IN WATER RESOURCES: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
For primary bibliographic entry see Field 2E.
W90-02507

BAYESIAN FRAMEWORK FOR INFERENCE IN FLOOD FREQUENCY ANALYSIS.
Newcastle Univ. (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02511

DEVELOPMENT OF DESIGN PROCEDURES FOR EXTREME FLOODS IN AUSTRALIA.
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02512

USE OF ADDITIONAL HISTORICAL INFORMATION FOR ESTIMATION AND GOODNESS OF FIT OF FLOOD FREQUENCY MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 2E.
W90-02519

EXTRAPOLATION ERROR IN FLOOD FREQUENCY ANALYSIS.
Zakir Husain Engineering Coll., Aligarh (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02520

EFFECT OF DISCHARGE MEASUREMENT ON THE RESULTS OF FLOOD FREQUENCY ANALYSIS.
East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology.
For primary bibliographic entry see Field 2E.
W90-02521

SOME RESEARCHES ON DETERMINATION OF RETURN PERIOD FOR HISTORICAL FLOOD IN ANALYSIS OF FLOOD FREQUENCY.
Mid-South Design Institute for Hydroelectric Project, MWREP, PRC. Guitang, Changsha, Hunan, China.
For primary bibliographic entry see Field 2E.
W90-02522

POTENTIAL AND APPLICATION OF FLOOD FREQUENCY DETERMINATIONS.
Espey, Huston and Associates, Inc., Austin, TX.
For primary bibliographic entry see Field 2E.
W90-02523

OPTIMAL PLANNING OF FLOOD CONTROL SYSTEMS BASED ON RISK ANALYSES OF FLOOD INUNDATION.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02531

APPLICATION OF SYSTEM RELIABILITY ANALYSIS TO FLOOD FORECASTING.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02532

4B. Groundwater Management

ANALYSIS OF FLEXIBLE DRAINS IN CHANGI RECLAMATION.
National Univ. of Singapore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W90-01960

RECHARGE AS AUGMENTATION IN THE SOUTH PLATTE RIVER BASIN.
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. W. Warner, D. K. Sunada, and A. Hartwell.
Colorado Water Resources Research Institute Completion Report No. 144, November 1986. 116p, 10 fig, 10 tab, 12 ref, 3 append.

Descriptors: *Surface-groundwater relations, *Groundwater recharge, *Artificial recharge, *Water supply, River basins, South Platte River, Colorado, Legal aspects, Judicial decisions, Groundwater budget, Recharge, Return flow, Hydrologic budget.

Artificial recharge is a newly emerging technology in water management in the South Platte River Basin of Colorado. Currently there are about 44 recharge sites being operated, mostly for the purpose of augmenting streamflows. Augmentation is needed to offset the stream depletion caused by pumping from the alluvium along the river. Pilot recharge projects were first tried in the early 1960s. Some of them were recharge demonstrations and some were research sites. They are summarized in this report with brief descriptions of each project. These pilot projects proved the feasibility of artificial recharge in the South Platte Basin. More recently water supply organizations have begun to establish augmentation/recharge sites, largely taking advantage of existing facilities such as canals and seepage ponds. Their physical characteristics, water supplies, operating plans, and the role of each site in an augmentation plan is described. The purpose of most of the artificial recharge sites is to produce return flow to the river for augmentation. The current analytical methods being used to calculate the timing and amount of return flow from a recharge site are reviewed. The two most popular methods are: (1) the Glover method; and (2) the Stream Depletion Factor method (based on the Glover method). Example applications of each method are given. The current laws and administrative rules which govern augmentation/recharge in the South Platte Basin are summarized. A typical plan for augmentation is documented in complete detail including the court decree (Fort Morgan Reservoir and Irrigation Company). (Author's abstract)
W90-02298

LEGAL PROBLEMS IN KARST TERRANES.
For primary bibliographic entry see Field 6E.
W90-02454

DISTRIBUTION OF KARST GROUNDWATER IN SOUTHERN PART OF DUSHAN, GUIZHOU PROVINCE AND ITS EXPLOITATION AND MANAGEMENT.
Guizhou Inst. of Tech., Guiyang (China).
For primary bibliographic entry see Field 2F.
W90-02456

CHARACTERISTICS OF KARST WATER--IMPREGNATED ORE DEPOSITS IN CHINA AND THE COMBINATION BETWEEN MINE-DEWATERING AND WATER SUPPLY.
Ministry of Geology and Mineral Resources, Beijing (China).
For primary bibliographic entry see Field 2F.
W90-02457

KARST ENVIRONMENT OF GUIYANG CITY--ITS MANAGEMENT AND PROTECTION.
The NO. 1 Hydrogeology and Engineering Geology Party of Guizhou, Guiyang, China.
X. Li.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 150-158. 1 fig.

Descriptors: *Karst hydrology, *Groundwater management, *China, *Environmental effects, *Water resources development, Groundwater pollution, Land use, Waste disposal, Reforestation.

Karst development and the distribution of water, soil and mineral resources in the water divide area on Guizhou Plateau along with the changes of karst environmental quality of Guiyang city and the factors influencing it were analyzed, and comprehensive management and protection measures were determined. The urban district should deal with pollution problems, while the suburbs should reestablish ecological balance. Central city development should be controlled, and satellite towns may be built along the downstream direction. By making full use of the eastern part with larger environmental capacity and greater ability of natural self-purification, the areas of less permeable rocks may be chosen as the disposal places of water materials. Forests for conservation of water supply and shelter should be planted to regulate surface and ground water runoff for water purification. Effective measures should be taken to dispose of mine residue and waste water in pits, and especially to deal with the coal mine pollution that seriously threatens the drinking water reservoir in the western suburbs. In addition, forests should be planted on steep slopes now used for cultivation. (See also W90-02444) (Mertz-PTT)
W90-02460

PREDICTION AND RATIONAL DEVELOPMENT AND UTILIZATION OF UNDERGROUND WATER RESOURCES IN HAIQUAN OF HUNAN PROVINCE.
The No.1 Hydrogeological and Engineering Geological Party of Hunan Province, China.
For primary bibliographic entry see Field 2F.
W90-02461

CONFLICT BETWEEN GROUNDWATER EXPLOITATION AND LIMESTONE QUARRYING IN THE KARST REGION OF WARSTEIN (FEDERAL REPUBLIC OF GERMANY).
Geologisches Landesamt Nordrhein-Westfalen, Krefeld (Germany, F.R.).
For primary bibliographic entry see Field 4C.
W90-02463

TAPPING AND PROTECTION OF UNDERGROUND WATER IN THE ADRIATIC KARST REGION RELATED TO THE NEW CONCEPTION OF STRUCTURE OF DINARIDES.
Naturhistorisches Museum, Vienna (Austria). Karstological and Speleological Dept.
For primary bibliographic entry see Field 2F.
W90-02464

GENESIS, REGIME AND UTILIZATION OF KARST WATERS IN WEST CARPATHIANS MTS. (CZECHOSLOVAKIA).
Geologicky Ustav Dionyza Stura, Bratislava (Czechoslovakia).
For primary bibliographic entry see Field 2F.
W90-02478

GEOLOGY OF THE UPPER PALEOZOIC AQUIFER IN WESTERN BELGIUM.
Katholieke Univ. Leuven (Belgium). Inst. for Earth Sciences.
For primary bibliographic entry see Field 2F.
W90-02487

HYDROGEOLOGIC STUDY OF A GYPSUM-DOLOMITE KARST AQUIFER IN SOUTHWESTERN OKLAHOMA AND ADJACENT PARTS OF TEXAS, U.S.A.
Geological Survey, Oklahoma City, OK.
For primary bibliographic entry see Field 2F.
W90-02490

KARST SYSTEM OF THE ALMIROS OF IRAKLION COASTAL SPRING (SYSTEME KARSTI-

QUE DE LA SOURCE LITTORAL ALMIROS D'IRAKLION).
For primary bibliographic entry see Field 2F.
W90-02499

4C. Effects On Water Of Man's Non-Water Activities

FORESTS AND WATER RESOURCES: PROBLEMS OF PREDICTION ON A REGIONAL SCALE.
Newcastle upon Tyne Univ. (England). Dept. of Geography.
M. D. Newson, and I. R. Calder.
Proceedings of the Royal Society of London. Series B, Biological Sciences PRLBA4, Vol. 324, No. 1223, p 283-298, August 31, 1989. 2 tab, 80 ref.

Descriptors: *Forest watersheds, *Forest hydrology, *Water resources development, Soil management, Land management, Climates, Prediction.

Forests have profound effects on water resources and it is essential that water resources be jointly considered with forests wherever in the world these assets are valuable for national development or for environmental balance. However, despite a strong and often urgent need for prediction in forest hydrology, universality of scientific guidance is seldom possible across climatic boundaries, between soil types, between land management practices and, occasionally, between species of tree. The current state of predictability of water use by forests, of hydrological extremes and of water quality factors, all of which affect the utilization of water resources are reviewed. Contrasts between climatic zones are stressed in relation to evaporation processes. In reviewing hydrological extremes and water quality, the influence of local soil management and land management is drawn out. There seems some justification for a continuation of lengthy and expensive hydrological experimentation, despite the urgency of the need for guidance in land use and land management. It is essential, however, to make maximum use of new spatial techniques that aid extrapolation from the detail provided by studies of process. (Author's abstract)
W90-02149

IMPACT OF FORESTS ON MESOSCALE METEOROLOGY.
Centre National de Recherches Meteorologiques, Toulouse (France).
J. C. Andre, P. Bougeault, J. F. Mahfouf, P. Mascart, and J. Noilhan.
Proceedings of the Royal Society of London. Series B, Biological Sciences PRLBA4, Vol. 324, No. 1223, p 407-422, August 31, 1989. 13 fig, 1 tab, 17 ref.

Descriptors: *Forest watersheds, *Forest hydrology, *Watershed management, *Meteorology, Crops, Heat transfer, Air circulation, Canopy, Model studies, Climates, Precipitation.

The effect of forests on local meteorological circulations is discussed with particular regard to the consequence of their lower albedo, enhanced roughness and larger minimal stomatal resistance when compared with agricultural crops. The effect of these is determined by numerical simulation using two different mesoscale atmospheric models. Emphasis is given to the surface energy budget because this is the driving mechanism behind atmospheric circulation at the mesoscale. It has been shown, both from observations taken during the HAPEX-MOBILHY experiment and from numerical simulations using two different, meso-beta-scale, three-dimensional models, that the impact of forest on mesoscale atmospheric circulation and local meteorology may be important. It is possible to observe the development of 'breeze' circulation over a forest whenever conditions are favorable, i.e. when there is enough available moisture in and around the forest, so that the evaporation rate from adjacent bare soil or agricultural crops or both is higher because of their lower minimal surface resistance. The forest canopy then transfers more sensible heat into the atmosphere than its surroundings, possibly leading to heat-island effects or breeze development or both at its edge if it covers a large enough area. This also has an impact on the development of cumulus convection, with a marked triggering of cloud convection over a forest during clear days. It is also very likely that forests influence local precipitation patterns because their larger capacity for intercepting precipitation leads to more re-evaporation immediately after the passage of a cold front. These effects are of most importance at global climate scales, as they provide a positive feedback mechanism for the interaction between the water cycle and the growth of vegetative canopies. (Author's abstract)
W90-02151

IMPLICATIONS OF TROPICAL DEFORESTATION FOR CLIMATE: A COMPARISON OF MODEL AND OBSERVATIONAL DESCRIPTIONS OF SURFACE ENERGY AND HYDROLOGICAL BALANCE.
National Center for Atmospheric Research, Boulder, CO.
R. E. Dickinson.
Proceedings of the Royal Society of London. Series B, Biological Sciences PRLBA4, Vol. 324, No. 1223, p 423-431, August 31, 1989. 6 fig, 7 ref.

Descriptors: *Climatology, *Forest watersheds, *Forest hydrology, *Climatology, *Rain forests, Deforestation, Canopy, Model studies, Evapotranspiration, Simulation analysis, Seasonal variation, Amazon River.

Quantitative estimates of the impacts of tropical deforestation on climate can only be considered through use of models of climate that contain adequate treatments of both the land and atmospheric components. Recent global climate model (GCM) calculations of the effect of removing the Amazon forest attempted to include a detailed canopy model of the forest and the assumed grass replacement. An important role for the structure of the forest canopy was suggested by this study. However, data of Shuttleworth on the seasonal variation of Amazon evapotranspiration show much lower values during the wet season than were obtained in the GCM study and, consequently, much less seasonal variation. The reason for this discrepancy is examined by using results both from the GCM used in the deforestation study and a three-year simulation with a more recent version. The major source of the discrepancy is found to be a large excess of net surface radiation in the GCM simulations, and an excess rainfall interception loss, which is a consequence of this excess radiation. The modelled transpiration appears to agree with the observations. (Author's abstract)
W90-02152

TAMING THE FLOOD: A HISTORY AND NATURAL HISTORY OF RIVERS AND WETLANDS.
Severn-Trent Water Authority, Birmingham (England).
For primary bibliographic entry see Field 6G.
W90-02288

LOSS OF OVERBANK STORAGE IN FLOODPLAIN MANAGEMENT.
Maricopa County Flood Control District, Phoenix, AZ.
For primary bibliographic entry see Field 6F.
W90-02398

LIVING WITH FLOODPLAINS: LAND DEVELOPMENT IN ARIZONA.
Cella Barr Associates, Tucson, AZ.
For primary bibliographic entry see Field 6F.
W90-02401

CHARACTERISTICS OF KARST WATER--IMPREGNATED ORE DEPOSITS IN CHINA AND THE COMBINATION BETWEEN MINE-DEWATERING AND WATER SUPPLY.
Ministry of Geology and Mineral Resources, Beijing (China).
For primary bibliographic entry see Field 2F.
W90-02457

KARST ENVIRONMENTAL EFFECT OF WATER-CONSERVANCY AND WATER-ELECTRICITY PROJECTS IN MOUNTAIN AREAS OF GUIZHOU, CHINA.
Guizhou Provincial Bureau of Water Conservancy and Electric Power, Guiyang (China).
J. Dai.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 135-143. 2 fig, 1 tab.

Descriptors: *Karst hydrology, *China, *Karst, *Water resources development, *Environmental effects, Hydroelectric plants, Climates, Geology, Water pollution, Cyclic storage.

The building of water-conservancy and water-electricity projects has resulted in a new environment in karst areas. It has changed or adjusted a series of cyclic conditions, such as stable geomorphology, climate, ecology, karst hydrogeology, engineering geology, natural stress and pollution. The building of reservoirs in these areas has resulted in a dualistic structure and changes in the three-dimensional karst massif, recharge, runoff, and recharge dynamics. Problems associated with reservoirs in karst areas are: reservoir seepage; surface fracturing and rockfall; and induced earthquakes. In order to prevent deposition and pollution, clastic rock and weathering materials, soil and sand are distributed alternately. It is necessary to establish and protect vegetation to reduce water loss and soil erosion. (See also W90-02444) (Mertz-PTT)
W90-02458

CONFLICT BETWEEN GROUNDWATER EXPLOITATION AND LIMESTONE QUARRYING IN THE KARST REGION OF WARSTEIN (FEDERAL REPUBLIC OF GERMANY).
Geologisches Landesamt Nordrhein-Westfalen, Krefeld (Germany, F.R.).
G. Michel.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 178-182. 4 fig, 7 ref.

Descriptors: *Water use, *Water demand, *Karst hydrology, *Groundwater management, *Water resources development, West Germany, Industrial water, Limestone, Drinking water, Quarries, Groundwater pollution, Groundwater depletion.

The karstic limestone region of Warstein forms an isolated deposit of massive limestones (Middle Devonian Massenkalk) within an area of regional aquicludes. It is of equal importance as a highly productive aquifer and as a raw material resource for the limestone and cement industries, with a production of approximately 4 million tons per year. The increasing conflict between groundwater abstraction for drinking purposes on the one hand and the industrial quarrying on the other hand is demonstrated. The minimum groundwater outflow from the karst complex, as determined from spring discharges and river base flow in the autumn low water period, is 22 million cubic meters per year from an area of 11.3 square km. A comprehensive tracer test was carried out in autumn 1982, to study the hydraulic connection within the limestone deposit. Groundwater flow follows predominantly the tectonic fracture directions. Reversal of the negative effects of groundwater abstraction and limestone quarrying can only be mastered if (1) no pollution from limestone quarrying toward the groundwater is admitted, (2) quarrying does not reach the groundwater level, and (3) any artificial drawdown from pumping in the quarries is avoided. The mining of the limestone resources may continue, but with restrictions in response to the seasonal groundwater level fluctuations of the region. (See also W90-02444) (Author's abstract)
W90-02463

EFFECTS OF LAND DRAINAGE ON GROUNDWATER RESOURCES IN KARSTIC AREAS OF IRELAND.
Trinity Coll., Dublin (Ireland). Dept. of Geography.
For primary bibliographic entry see Field 6G.
W90-02466

FLOOD DAMAGE-FREQUENCY ANALYSIS OF AN URBANIZING WATERSHED.
Louisville Univ., KY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02535

4D. Watershed Protection

MICROMETEOROLOGY OF TEMPERATE AND TROPICAL FOREST.
Institute of Hydrology, Wallingford (England).
W. J. Shuttleworth.
Proceedings of the Royal Society of London. Series B, Biological Sciences PRLBA4, Vol. 324, No. 1223, p 299-334, August 31, 1989. 11 fig, 2 tab, 97 ref. append.

Descriptors: *Meteorology, *Micrometeorology, *Forest watersheds, *Forest hydrology, *Watershed development, *Solar radiation, Canopy, Diversity, Simulation models, Micrometeorology, Climates, Deforestation.

The literature on the micrometeorology of temperate and tropical forests is reviewed to determine whether structural or species difference between these biomes alters their interaction with the atmosphere. Considerable consistency is found in the value of those whole-canopy features of most importance to this interaction, namely solar-reflection coefficient, through-canopy radiation absorption, aerodynamic roughness, the symptoms of near-surface K-theory failure, the canopy store for rainfall interception and the magnitude and environmental response of their bulk stomatal (surface) resistance. Typical values of these parameters and functions are given with a view to their potential use in climate simulation models. Attention is drawn to the fact that this similar micrometeorological response can generate different time-average surface-energy partitions when interacting with different climates and, in particular, alters between the edge and the middle of continents. This is of considerable significance, implying tropical deforestation is likely to have the greatest effect on river flow (though not climate) at continental edge and island locations. The similar micrometeorological response of forests is interpreted as the necessary consequence of energy and mass (water) conservation acting as an area average on vegetation that is, by definition, dense and extensive, to reconcile a characteristically tall growth habit with a perennial nature. (Author's abstract)
W90-02150

RUNOFF AND EROSION CONTROL IN POTATO FIELDS.
Agricultural Research Organization, Bet-Dagan (Israel).
M. Agassi, I. Shainberg, D. Warrington, and M. Ben-Hur.
Soil Science SOSCAK, Vol. 148, No. 2, p 149-154, August 1989. 5 fig, 2 tab, 10 ref.

Descriptors: *Runoff, *Agricultural runoff, *Erosion control, Potato fields, Phosphogypsum, Slopes, Rainfall, Sedimentation, Rainfall penetration, Diked-furrows technique.

In ridged and furrowed potato fields, the beneficial effect of phosphogypsum (PG) and of the diked-furrows technique on runoff and erosion control was studied. Spreading 10 t/ha of PG over the soil surface after seeding reduced runoff from the field 6-fold and reduced soil loss from the ridges to the bottom of the furrows 20-fold. In the diked-furrows treatment there was no runoff at all and ridge erosion was similar to that of the control. The effect of 5 and 25% slope and addition of PG on the runoff and erosion from the same sandy soil (Typic Rhodoxeralf) was studied in the laboratory using a rain simulator. When the slope was increased, soil loss increased 2-fold and 12-fold in the PG treatment and the control, respectively. PG was very beneficial in preventing soil erosion from the steep slope. The dissolution of PG by the rainwater and the ensuing release of electrolytes decreased soil erosion by: (1) increasing the fraction of rain that penetrated into the soil, (2) increasing the stability of the aggregates at the soil surface, and (3) enhancing the rate of entrained sediment deposition. (Author's abstract)
W90-02154

IMPACT OF DURATION OF DRAINAGE ON THE SEED BANKS OF NORTHERN PRAIRIE WETLANDS.
Iowa State Univ., Ames. Dept. of Botany.
C. E. Wienhold, and A. G. van der Valk.
Canadian Journal of Botany CJBOAW, Vol. 67, No. 6, p 1878-1884, June 1989. 3 fig, 3 tab, 32 ref.

Descriptors: *Wetlands, *Iowa, *Minnesota, *North Dakota, Seeds, Vegetation regrowth, Restoration, Drainage, Seed banks.

To determine the potential role of seed banks in the restoration of drained wetlands, the seed banks of 30 extant and 52 drained and cultivated prairie potholes were sampled in Iowa, Minnesota, and North Dakota; the potholes had been drained between 5 and 70 years ago. The midsummer vegetation of most of these potholes was also sampled. The number of species in the seed bank of a pothole declined from a mean of 12.3 in extant potholes to 7.5 in potholes drained up to 5 years ago, 5.4 in those drained up to 10 years ago, 5.0 in those drained up to 20 years ago, 7.4 in potholes drained up to 30 years ago, 3.2 in those drained up to 40 years ago, and 2.1 in potholes drained up to 70 years ago. The mean total seed density of extant potholes was 3600 seeds/sq m. It increased to 7000 seeds/sq m up to 5 years after drainage, but then declined rapidly to 1400 after up to 10 years after drainage, 1200 after up to 20 years, 600 after up to 30 years, 300 after up to 40 years, and 160 after up to 70 years after drainage. Changes in both species richness and seed density with increasing duration of drainage varied from state to state. About 60% of the species present in the seed banks of extant or recently drained wetlands were not detected in wetlands that had been drained for more than 20 years. Vegetation surveys of extant and drained wetlands indicated that as many or more wetland species not detected in the seed bank were present in the vegetation, as there were wetland species in the seed bank. (Author's abstract)
W90-02238

KINZUA DAM, ALLEGHENY RIVER, PENNSYLVANIA AND NEW YORK: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-02292

SOIL CONSERVATION SERVICE AND FLOODPLAIN MANAGEMENT: A LOOK AHEAD.
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 4A.
W90-02370

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

ALTERNATIVE METHOD FOR RA DETERMINATIONS IN WATER.
Angelo State Univ., San Angelo, TX. Dept. of Physics.
D. H. Loyd, and E. N. Drake.
Health Physics HLTPAO, Vol. 57, No. 1, p 71-77, July 1989. 4 fig, 3 tab, 8 ref.

Descriptors: *Pollutant identification, *Radium radioisotopes, *Well water, *Public health, Radioisotope detection, Aquifers, Texas.

Concentrations of radium-226 and radium-224 in 13 wells distributed throughout McCulloch and Mason Counties in the Hickory Aquifer of the Llano Uplift Region of West-Central Texas are reported. Measurable alpha-particle activity was present in all wells, with seven wells having 226Ra-radioactivity concentrations greater than 185 Bq/cu m (5 pCi/L). An alternative methodology for measuring 226Ra, 224Ra, and 228Ra is described. The EPA-approved methodology for estimating total Ra is shown to be invalid for aquifers containing significant levels of 224Ra. Alpha-particle activity measurements made in the interval of 12 to 300 h after Ra isolation lead to self-consistent solutions for radioactivity concentrations of 226Ra and 224 Ra, with negligible contributions from 228Ra. Radioactivity concentrations of 228Ra can be calculated from the grow-in terms for this isotope used with alpha-particle activity measurements at post-isolation times significantly longer than 800 h. Comparison of the 226Ra radioactivity concentration with that reported previously by the Texas Department of Health for a single well indicates acceptable agreement. However, the radioactivity concentration attributable to 228Ra for the same well was found to be in significant disagreement with the Texas Department of health value. (Author's abstract)
W90-01950

SIMULTANEOUS DETERMINATION OF 224RA, 226RA AND 228RA IN LARGE VOLUMES OF WELL WATERS.
Argonne National Lab., IL.
H. Jiang, and R. B. Holtzman.
Health Physics HLTPAO, Vol. 57, No. 1, p 167-168, July 1989. 1 tab, 4 ref.

Descriptors: *Pollutant identification, *Radium radioisotopes, *Well water, Aquifers, Laboratory methods, Radioisotope detection.

The Environmental Protection Agency considers radium isotopes in drinking water a major concern and it assumes that the concentration ratio of 226Ra/228Ra is equal to or less than 1.5. However, survey results show that the ratios of 226Ra/228Ra in water range from greater than 14 to less than 0.07. Because rations less than 1.5 are not unusual, excessive 228Ra in many samples may be missed. A procedure is described that uses gamma-ray spectrometry for the determination in well waters of the Ra isotopes, 226Ra, 228Ra, and 224Ra. First, the Ra isotopes are co-precipitated with barium and lead sulfates and the precipitate is counted on a low-background detector which has a high resolution for gamma rays. The spectra are collected on a 4096-channel pulse-height analyzer and the data are processed by computer techniques to identify and determine the activities of the respective nuclides. Because of the short half-life of the 224Ra (3.66 d), the precipitate should be counted within 4 d of collection of the sample. Since the determinations of 224Ra and 226Ra rely on the detection of gamma rays from the short-lived radon daughters, and the Rn isotopes are gases lost from the water samples during heating, time must be allowed for the growth of the Rn and its daughters for counting. The recovery of Ra in the analysis is essentially quantitative, as demonstrated by the recovery of 228Ra of 102 plus or minus 6% (standard deviation) for eight samples spiked with this nuclide. The detection limit of the procedure for each of the nuclides, with about 1000 min of counting time, was estimated to be about 0.2 Bq (5 pCi), or about 0.01 Bq/L. (Shidler-PTT)
W90-01951

QUANTITATIVE HIGH-RESOLUTION GAS CHROMATOGRAPHY AND MASS SPECTROMETRY OF TOXAPHENE RESIDUES IN FISH SAMPLES.
National Water Research Inst., Burlington (Ontario). Research and Applications Branch.
F. I. Onuska, and K. A. Terry.
Journal of Chromatography JOCRAM, Vol. 471,

No. 1, p 161-171, June 2, 1989. 4 fig, 3 tab, 13 ref.

Descriptors: *Pollutant identification, *Tissue analysis, *Fish, *Toxaphene, *Mass spectrometry, *Chromatography, Laboratory methods.

An analytical method is described which permits the determination of ppb (1 microg/kg) levels of toxaphene in fish tissues. Interferences from biogenic and xenobiotic substances are reduced even with low-resolution mass spectrometry. The methodology has a low susceptibility to false positive determinations, which could result form the presence of a wide variety of co-contaminants. The method is based on the measurement of a signal representative of the toxaphene residue relative to a known amount of an internal standard chlorine-37-labeled compound. A modular approach to toxaphene enrichment has permitted a moderately simple procedure, significantly reducing analytical time requirements and the number of sample manipulations, and making the procedure amenable to automation. The reliability and accuracy of the procedure are demonstrated by the results of intralaboratory and interlaboratory studies. The methodology has been validated and the presented data indicate that the detection limit is 1 microg/kg of total toxaphene. Toxaphene recovery from fish at concentration levels between 0.1 and 10 microg/g was 84 plus or minus 12%. (Author's abstract)
W90-01953

DETERMINATION OF CHLOROPHENOLS IN WATER BY DIRECT ACETYLATION AND SOLID-PHASE EXTRACTION.
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia). Inst. of Water Technology and Environmental Protection.
V. Janda, and H. van Langenhove.
Journal of Chromatography JOCRAM, Vol. 472, no. 1, June 9, 1989. 3 fig, 2 tab, 6 ref.

Descriptors: *Pollutant identification, *Chemical analysis, *Water analysis, *Phenols, Water samples, Direct acetylation, Gas chromatography.

Tap water, spiked with different chlorophenols, was subjected to direct acetylation with acetic anhydride. Solid-phase extraction of the acetylated chlorophenols was accomplished with polypropylene cartridges. Following removal of residual water from the cartridge, the chlorophenol acetates were desorbed with 1 ml of benzene. The eluate was dried, and after addition of internal standard (p-bromophenol acetate), gas chromatograph analysis was performed. Recoveries for all the chlorophenols were always higher than 90%. The advantages of the method included: (1) nonionogenic acetates could be isolated from water more easily than highly polar free chlorophenols; (2) derivatization in the aqueous solution was rapid; and (3) in comparison with repeated liquid/liquid extraction, manipulations with large volumes of solvents were avoided. (Bazar-PTT)
W90-01954

RELATIVE IMPORTANCE OF BIO-AND GEOPOLYMERS IN INTERSTITIAL WATERS: SPECTROFLUOROMETRY AND BIOASSAY STUDIES (IMPORTANCE RELATIVE DES BIO-AND GEOPOLYMERES DANS LES EAUX INTERSTITIELLES: UTILISATION DE LA SPECTROFLUORIMETRIE ET ESSAIS BIOCHIMIQUES).
Universite de Toulon et du Var, La Garde (France). Lab. de Recherches de Chimie Marine des Organometalliques.
C. Benamou, M. Richou, and J. Benaim.
Water Research WATRAG, Vol. 23, No. 9, p 1127-1136, 1989. 6 fig, 4 tab, 45 ref. English summary.

Descriptors: *Water pollution sources, *Pollutant identification, *Interstitial water, *France, *Polymers, Spectrophotometry, Sediments, Organic matter, Humic acids, Fulvic acids, Hydrogen ion concentration, Carbohydrates, Proteins, Lipids, Microbial degradation.

In order to define 'a quality' of the sea bottom, sediments were sampled in the vicinity of three different kinds of outfalls at sites on the French Riviera receiving municipal sewages: (1) Cannes receiving treated effluents; (2) Nice where the treatment plant is being built; and (3) Antibes where there is no treatment at all. Dissolved organic matter in interstitial water (IW) extracted from sediments and referred to as geopolymers (humic substances) and biopolymers (glucids, lipids, and proteins) was analyzed. Humic acids (HA) and fluvic acids (FA), extracted from marine sediments of the same origin, were used for the preparation of standard solutions. The emission spectra of these standards were recorded at various pH values. FA show one typical emission band at 450 nm whereas two bands are observed for HA at 450 and 530 nm. A humic character can thus be defined by the emission at 530 nm attributed to a conjugate base of HA. When applied to IW at natural pH, the FA/HA ratio can be estimated. As expected, IW contains mostly FA, but some samples present noticeable amounts of HA (mainly at the previous places of outfalls). A simple test using pH adjustments of IW can also be used for qualitative evaluation of dissolved HA. Usual spectrophotometric methods were used for the titrations of carbohydrates, proteins, and lipids. Contrarily with proteins and lipids the carbohydrates concentrations measured in IW are higher and practically constant (30-46 mg/L). Exo-enzymes hydrolases in IW can be directly detected using commercial APIZYM systems. In this way, a global microbial activity parameter is determined for each site. High values are obtained for the three sites studied and particulary in Nice. A review of the 19 cell-free enzymes detected is also presented. (Author's abstract)
W90-02010

ISOLATION OF WILD-TYPE HEPATITIS A VIRUS FROM THE ENVIRONMENT.
Universita degli Studi 'Tor Vergata', Rome (Italy). Dept. of Public Health.
M. Divizia, P. D. Napoli, A. Venuti, R. Perez-Bercoff, and A. Pana.
Water Research WATRAG, Vol. 23, No. 9, p 1155-1160, 1989. 4 fig, 1 tab, 36 ref.

Descriptors: *Viruses, *Culturing techniques, *Pathogens, Hepatitis, Tiber River, Filtration method, Antibodies.

Three isolates of human hepatitis A virus (HAV) were cultivated directly from polluted Tiber water on Frp/3 cells. From 50 to 125L of water were prefiltered through 10 and 1 microm polygard filters and concentrated using a molecular ultrafiltration system. The washing buffer was acid-pH precipitated or concentrated by ultrafiltration. Each sample was neutralized with a pool of antibodies against all the enteroviruses excluding hepatitis A virus. Three samples obtained from prefilters were scored as positive. Hepatitis A virus was identified by commercial ELISA test, indirect immunofluorescene, neutralization test, performed with polyclonal or monoclonal antibody, and by hybridization test with cDNA probes. (Author's abstract)
W90-02013

OPTIMIZATION OF A SAMPLING DESIGN AND SIGNIFICANCE OF BACTERIAL INDICATORS: APPLICATION TO THE BACTERIOLOGICAL SURVEY OF THE ARDECHE RIVER, FRANCE.
Montpellier-2 Univ. (France). Lab. d'Hydrobiologie.
B. Baleux, and M. Troussellier.
Water Research WATRAG, Vol. 23, No. 9, p 1183-1190, 1989. 6 fig, 4 tab, 14 ref.

Descriptors: *Bioindicators, *Pollutant identification, *Pathogens, *Coliforms, *Monitoring, Sampling, Path of pollutants, Statistical analysis, Aeromonas, Pseudomonas, Enterobacteriaceae, Correlation analysis, France.

Difficulties encountered in monitoring the bacterial pollution of rivers were investigated during the bacteriological survey of one of the most popular recreational rivers of France. The problems of the representativeness of bacterial indicator sampling was first studied by analyzing preliminary sampling results using nested ANOVA and estimating the error percentage (confidence interval/mean) obtained with different simulated sampling strategies. The best strategy i.e. giving the lowest error percentage of the bacterial mean, was applied to a survey of fecal and total coliform and fecal streptococci counts at different sampling locations (11) along the river, repeated five times during the summer of 1984. Two opportunistic pathogens of nonfecal origin were also counted at the same time as the bacterial populations isolated as fecal and total coliforms were investigated. Generally, the confidence intervals around the count means were low, and allowed a clear separation of the polluted and the nonpolluted zones of the river based on European Community standards. The counts of the three standard bacterial indicators were significantly correlated along the whole river. In contrast, the variations of Aeromonas spp and Pseudomonas aeruginosa counts were generally not correlated with those of the indicators. All the bacterial strains isolated as fecal coliforms were identified as Enterobacteriaceae and 70.8% of them were Escherichia coli. Only 24.5% of total coliforms were identified as Enterobacteriaceae. The last results indicate that, despite the standards, the total coliform variable is not relevant, for assessing the recreational quality of river waters. Replacement of this variable by others, such as easily measurable pathogenic bacteria of nonfecal origin, is recommended. (Author's abstract)
W90-02017

IDENTIFICATION OF SURFACTANTS IN WATER BY FAB MASS SPECTROMETRY.
Aigues de Barcelona (Spain).
F. Ventura, J. Caixach, A. Figueras, I. Espalder, and D. Fraisse.
Water Research WATRAG, Vol. 23, No. 9, p 1191-1203, 1989. 8 fig, 3 tab, 23 ref.

Descriptors: *Water analysis, *Surfactants, *Pollutant identification, *Mass spectrometry, Nonionic compounds, Cationic compounds, Anionic compounds, Quantification, Sensitivity.

An application of fast atom bombardment (FAB) for identification of some organic micropollutants was performed. A study of the most common surfactants, including non-ionic, cationic and anionic compounds was carried out and the results obtained used to build a table for rapid characterization of surfactants in real samples. Negative FAB and tandem mass spectrometry (CID-MIKE) were also occasionally employed, when two or more compounds gave the same series of peaks. Other disadvantages came from difficulty of pollutant quantification in real samples. Sensitivity limits for standards varied from low to upper nanogram range for cationic to anionic surfactants. Raw and drinking water extracts of Barcelona (N.E. Spain) were analyzed and the most common surfactants and some brominated derivatives were identified. (Author's abstract)
W90-02018

MEASURING THE BIOLOGICAL EFFECTS OF POLLUTION: THE MUSSEL WATCH APPROACH.
Marine Biological Association of the United Kingdom, Plymouth (England).
B. L. Bayne.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1089-1100, 1989. 7 fig, 1 tab, 31 ref.

Descriptors: *Water pollution effects, *Monitoring, *Pollutant identification, *Bioindicators, *Mussels, Bioaccumulation.

The Mussel Watch approach to environmental monitoring is based upon the fact that suspension-feeding bivalves such as mussels, oysters and clams accumulate and concentrate certain environmental contaminants significantly above ambient levels in the environment, facilitating accurate chemical analysis and assessment. Some of the available 'biological effects techniques' for measuring the effects of pollutants on marine organisms are illustrated by

reference to a recent workshop at which they were tested. The following conclusions were drawn from this workshop: (1) The physiological determination of the scope for growth, which represents an integrated measurement of the health and well-being of the organism, is clearly effective in detecting the sub-lethal impact of mussels within a complex field situation where the mussels experience a mixture of contaminants; (2) Measurements of lysosomal function correlate well with anticipated cellular and tissue measurements and, in general, were effective in detecting biological effects of pollutants in the field; however, variability was apparent which would render the interpretation of the data with respect to measured level of organic contaminants in the tissues difficult. This variability was largely due to differences in the reproductive status of the mussels; and (3) Some biochemical determinations of the mixed function oxidase system seemed to confirm increased levels of activity with increased exposure to organic contaminants, but knowledge of the biochemistry of these reactions in invertebrates is presently too scant to support their use in field monitoring. In spite of these uncertainties, the overriding conclusion is that biological responses by mussels to contamination in the field can be used to discriminate between polluted and non-polluted sites and can be of use in monitoring the biological impact of contamination. (Sand-PTT)
W90-02051

WATER QUALITY INDICES FOR THE MANAGEMENT OF SURFACE WATER QUALITY.
Middlesex Polytechnic, Enfield (England).
M. A. House, and D. H. Newsome.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1137-1148, 1989. 10 tab, 16 ref.

Descriptors: *Pollutant identification, *Water analysis, *Water quality indices, *Water quality standards, *Water quality management, Indicators, Mathematical analysis, Water pollution, Classification.

The need for a simple, objective and reproducible numeric scale to represent water quality in terms that all types of user will accept has been apparent for the last 20 years. Subjective classifications of water quality have been made, but they are seldom reproducible and lack sensitivity. Now, a new family of water quality indices has been developed that can be used either independently or in combination which promise to overcome previous criticisms. The use of a water quality index allows 'good' and 'bad' water to be quantified by reducing a large quantity of data on a range of physico-chemical and biological determinations to a single number in a simple, objective and reproducible manner. These numbers allow meaningful spatial and temporal comparisons to be made and integrate the effect of the various pollutants present. These indices are currently being used by a UK water authority to assess their utility to personnel responsible for both the planning and day-to-day management of water quality. (Sand-PTT)
W90-02055

APPLICATION OF A WATER QUALITY INDEX TO RIVER MANAGEMENT.
North West Water Authority, Warrington (England).
J. M. Tyson, and M. A. House.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1149-1159, 1989. 2 fig, 8 tab, 5 ref.

Descriptors: *River management, *Water quality management, *Water quality standards, *Water quality indices, England, Decision making.

River water quality in the UK is categorized within a five class system developed by the National Water Council in 1978. This system suffers from problems of subjectivity, reproducibility and sensitivity which limit its value in identifying benefits of management practice. It was expected, in North West Water Authority, that use of the Water Quality Index (WQI) developed previously would meet information requirements for the management of river water quality. Application of the WQI to several thousand individual data sets has demonstrated that the system fulfills many requirements. In particular, any element of subjectivity is contained within the methodology which can be applied in a simple standard manner to yield results which are sensitive to variations in quality and the value of a continuous scale in discriminating between different sets of results has been proven. Further, the system is made more robust by the ability to set results within selected confidence intervals thereby aiding decision making. Computerized data handling enables the Index to produce valuable management information in a timely and efficient manner (Sand-PTT)
W90-02056

TESTING OF COLORED SAMPLES FOR TOXICITY BY THE ALGAL-ATP BIOASSAY MICROPLATE TECHNIQUE.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
K. K. Kwan.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 47-53, 1989. 2 fig, 1 tab, 14 ref.

Descriptors: *Toxicity, *Bioassay, *Color, *Pulp wastes, *Algae, Adenosine triphosphate, Interferences, Optical densities, Physicochemical properties.

Algal-ATP bioassay is a relatively simple, inexpensive, reliable and fast testing procedure for toxicity assessment. This algal growth inhibition bioassay technique using Selenastrum capricornutum was used to assess the toxicity levels in pulp and paper mill and thermomechanical mill effluent samples. Pulp and paper mill and thermomechanical mill effluent samples contain a wide range of colors due to certain physico-chemical properties of the test samples. Three samples with optical densities ranging from 0.27 to $>$ 2.0 (at 600 nanometer) were used to evaluate the relationship of color and sample concentration. Twenty microliters of ATP standard which yielded 400-500 RLU was added to each sample and dilution (100, 50, 25, and 12.5%), ATP measurements were performed, and a color reduction graph was plotted. Initially 10 of the thirteen samples tested produced a toxic effect. However, after color and physico-chemical effects were removed only 7 produced a toxic effect. Therefore, of the thirteen samples tested, seven were toxic, three produced stimulatory effects and three were negative for both toxic and stimulatory effects. Color was not a function of concentration. Therefore, in a dose-response study of more than one concentration it is important to be aware of the nature and extent of interferences due to the inherent complexity of some environmental samples. (White-Reimer-PTT)
W90-02113

APPROPRIATENESS OF AUFWUCHS AS A MONITOR OF BIOACCUMULATION.
Savannah River Ecology Lab., Aiken, SC.
M. C. Newman, and A. W. McIntosh.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 83-100, 1989. 1 fig, 83 ref. DOE and U of Georgia Savannah River Ecology Laboratory Grant DE-AC09-76SROO-819.

Descriptors: *Pollutant identification, *Monitoring, *Bioaccumulation, *Aufwuchs, Trace elements, Aquatic life, Pollutants, Bioavailability.

Aufwuchs, procedurally defined as material accumulating on submerged surfaces, is being used increasingly to monitor trace element bioaccumulation in aquatic biota. Procedurally-defined aufwuchs is a complex mixture of biotic and abiotic components. Both biotic and abiotic components can be avid concentrators of trace elements. Consequently, bioaccumulation data generated from poorly-characterized, procedurally-defined aufwuchs may not accurately reflect accumulation by biota. Further, total concentrations of trace elements in procedurally-defined aufwuchs may not be indicative of the amount of contaminant available for trophic transfer. This potentially complicating factor can be minimized by exposing substrates for relatively short periods of time or expressing the contaminant levels on an areal basis as well as a gravimetric basis. This problem could be most prominent when contaminant concentrations or physico-chemical conditions change at a rate that allows diffusion-limited adsorption kinetics to become significant. Alternative measures of bioavailable contaminant such as those developed for sediment-bound contaminants have not been adaquately assessed or utilized for procedurally-defined aufwuchs. (Author's abstract)
W90-02115

SINGLE-COLUMN ION-CHROMATOGRAPHIC DETERMINATION OF CHROMIUM (VI) IN AQUEOUS SOIL AND SLUDGE EXTRACTS.
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
H. C. Mehra, and W. T. Frankenberger.
Talanta TLNTA2, Vol. 36, No. 9, p 889-929, September 1989. 3 fig, 3 tab, 12 ref.

Descriptors: *Pollutant identification, *Chromium, *Heavy metals, *Chromatography, Soil analysis, Soil chemistry, Sludge, Soil contamination.

Chromium finds its way into soils through industrial wastes such as electroplating sludge, tannery wastes, manufacture of corrosion inhibitors, and municipal sewage sludges. Single-column ion-chromatography (SCIC) was investigated as a routine, rapid, precise and selective analytical method for the determination of chromium (VI) in aqueous extracts of soil and sewage sludge. Chromatographic parameters were optimized for determination of Cr(VI), NO3(-), SO4(--). A low-capacity resin-based column was used for the separation and the anions were determined by conductometric detection. Para-hydroxybenzoic acid (5mM) at pH 8.5 was used as the eluent. The limit of detection, defined as S/N=3, was 92 micrograms per liter. The resolution between Cr(VI) and SO4(--) was 2.8, the precision ranged from 0.9% for NO3(-) to 2.0% for Cr(VI) with a 500 microliter injection. The SCIC results for Cr(VI) agreed closely with those obtained by inductively coupled argon-plasma emission and spectrophotometry. (Ence-PTT)
W90-02134

ANALYSIS OF SUMMERTIME CLOUD WATER MEASUREMENTS MADE IN A SOUTHERN APPALACHIAN SPRUCE FOREST.
Tennessee Valley Authority, Muscle Shoals, AL. Atmospheric Science Dept.
L. M. Reisinger, and R. E. Imhoff.
Water, Air and Soil Pollution WAPLAC, Vol. 45, No. 1-2, p 1-15, May 1989. 7 tab.

Descriptors: *Chemistry of precipitation, *Precipitation, *Virginia, *Acid rain, Cloud physics, Sulfates.

An analysis of cloud water measurements made during the summers of 1986 and 1987 at Whitetop Mountain, Virginia (36.639 degrees N, 81.605 degrees W) is presented. Analysis of cloud water chemistry, cloud type, and air mass origin are made for each cloud event occurring during one 3 to 4 week measurement 'intensive' per year along with an investigation of Regional source/receptor relationships. Cloud water concentrations of major ions (i.e., H(+), SO4(2-), NO3, and NH4(+)) are consistently higher during orographically formed 'cap' cloud events. Differences in cloud liquid water content between cap and frontal cloud events explains most, but not all, of the cloud water ion concentration differences. The remaining difference can be explained by greater rainfall associated with frontal cloud events. Most of the cloud water sulfate measured at Whitetop Mountain is apparently due to nucleation of aerosol sulfate within cloud droplets and not to local in-cloud aqueous phase SO2 oxidation. No strong source/receptor relationships were evident from this analysis. Most 72 hr air trajectories arriving at Whitetop Mountain during the cloud events described originated in the southeastern United States. Few came from the Ohio River Valley or the northeastern United States. (Author's abstract)
W90-02155

PHOTOACOUSTIC DETECTION OF ORTHO-PHOSPHATE IN AQUEOUS SOLUTION.
Agricultural Univ., Wageningen (Netherlands). Laser Photoacoustic Lab.
For primary bibliographic entry see Field 7B.
W90-02159

AQUATIC HYPHOMYCETES AS INDICATORS OF CONTAMINATION (HYPHOMYCETES ACUATICOS COMO INDICADORES DE CONTAMINACION).
Instituto Profesional Osorno (Chile). Dept. Ciencias Exactas y Naturales.
J. Burgos E., and H. Castillo P.
Biota, Vol. 2, p 1-10, 1986. 1 fig, 4 tab, 13 ref. English summary.

Descriptors: *Aquatic fungi, *Hyphomycetes, *Water pollution effects, *Bioindicators, Damas River, Chile, Species diversity, Anaerobic conditions.

The diversity of aquatic Hyphomycetes colonizing willow leaves was studied at the end of summer and early autumn in two sectors of the Damas River (Osorno, Chile), one clean and one polluted. All leaves placed in the clean sector of the river were colonized with 10 species with active growth, compared to only 2.5% of those placed in the contaminated sector, where the only detected species growing was Triscelophorus acuminatus. By considering conidia present on leaves, the variety of species for the clean and polluted sectors of the river was 17 and 4, respectively. The variety of species was higher on leaves that stayed submerged for an extended period (43 days). The more abundant species in the clean sector were T. acuminatus (90%), Lemonniera aquatica (86%), Tetracladium marchalianum (57%) and Clavariopsis aquatica (57%). It is concluded that the condition of organic contamination of the Damas River, which produces an oxygen deficit of 85% at the end of the summer and the beginning of autumn is limiting for the development of the aquatic Hyphomycetes. Therefore species diversity values (variety) as low as 1, compared with values of 10 or more, are indicators of contamination with conditions approaching an anaerobic state. (Author's abstract)
W90-02161

ISOLATION OF AEROMONAS SPP. FROM WATER BY USING ANAEROBIC INCUBATION.
South Australia Engineering and Water Supply Dept., Salisbury. State Water Labs.
For primary bibliographic entry see Field 5F.
W90-02163

DETECTION OF ACINETOBACTER SPP. IN RURAL DRINKING WATER SUPPLIES.
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
For primary bibliographic entry see Field 5F.
W90-02165

RELATION BETWEEN AEROMONAS AND FAECAL COLIFORMS IN FRESH WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W90-02175

SEASONAL VARIATION OF POLLUTION INDICATORS IN A WILDFOWL RESERVE (DONANA NATIONAL PARK, SPAIN).
Centro de Investigaciones Biologicas, Madrid (Spain).
R. Rivilla, and C. C. Gonzalez.
Journal of Applied Bacteriology JABAA4, Vol. 67, No. 2, p 219-223, August 1989. 2 fig, 3 tab, 19 ref. Comision Asesora para el Desarrollo de la Investigacion Cientifica y Tecnica grant 603/617.

Descriptors: *Water pollution, *Bioindicators, *Pathogenic bacteria, *Coliforms, *Fecal streptococci, *Wildlife habitats, Seasonal variation, Donana National Park, Spain.

Pollution indicators in Donana National Park in southwestern Spain show a cyclical seasonal pattern with maximum level in the autumn and minimum in the spring. While fecal streptococci proved to be the best indicator microorganisms in this type of salty, alkaline environment, total coliforms gave an overestimation of pollution because of the presence of hydroteluric coliforms. (Author's abstract)
W90-02176

TOXICITY VERSUS AVOIDANCE RESPONSE OF GOLDEN SHINER, NOTEMIGONUS CRYSOLEUCAS, TO FIVE METALS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
S. I. Hartwell, J. H. Jin, D. S. Cherry, and J. Cairns.
Journal of Fish Biology JFIBA9, Vol. 35, No. 3, p 447-456, September 1989. 2 fig, 3 tab, 37 ref. American Electric Power Company, Columbus, Ohio grant 43216-6631.

Descriptors: *Fish behavior, *Bioassay, *Bioindicators, *Water pollution effects, *Toxicity, *Heavy metals, Chromium, Copper, Cadmium, Arsenic, Selenium, Golden shiner, Avoidance behavior.

Avoidance thresholds and 96-h LC50 values were determined for golden shiners, Notemigonus crysoleucas, for Cr, Cu, Cd, As, and Se. The avoidance concentrations were 73, 26 and 28 microgram/l for Cr-VI, Cu and As-III, respectively. Cd and Se were not avoided at experimental concentrations up to 68 and 3489 microgram/l, respectively. Acute flow-through 96-h LC50 values for Cr-VI, Cu, and As-III were 55.0, 84.6, and 12.5 mg/l, respectively, which were more than two orders of magnitude above avoidance concentrations. The acute flow-though 96-h LC50 values for Cd and Se were 2.8 and 11.2 mg/l, respectively. These concentrations are 31 and 2.2 times the highest concentration employed in the avoidance tests, neither of which were avoided by the test organisms. Thus, simple toxicity tests do not identify the environmental hazard of some elements, and the most toxic elements may not elicit a behavioral response. When used in concert with tests of organism function, more realistic indicators of environmental hazard or safety may be determined. (Author's abstract)
W90-02178

SUITABILITY OF FOUR MEDIA FOR ENUMERATING AEROMONAS SPP. FROM ENVIRONMENTAL SAMPLES.
Technical Univ. of Denmark, Lyngby.
S. Knochel.
Letters in Applied Microbiology LAMIE7, Vol. 9, No. 2, p 67-69, August 1989. 3 tab, 16 ref. Danish Technical Research Council grant 16-4113.H and Danish Agricultural Research Council grant 13-3925.

Descriptors: *Culturing techniques, *Pollutant identification, *Aeromonas, *Pathogenic bacteria, *Bacterial analysis, *Growth media, Agars.

Starch ampicillin agar, dextrin fuschsin sulfite agar (DFS) and blood agar with 10 mg (BA-10) and 30 mg (BA-30) ampicillin/l, respectively, were evaluated for enumeration of Aeromonas spp. from environmental samples. Recovery from pure cultures was excellent on all media except for ampicillin-sensitive strains on the ampicillin-containing media. With natural samples, the ability to differentiate Aeromonas from the background microflora was best on SA agar where 85% presumptive Aeromonas colonies were confirmed, compared with 18% on DFS, 36% on BA-10 and 40% on BA-30. Prolonged incubation caused a decrease in the differentiating ability. (Author's abstract)
W90-02208

FRESHWATER SHRIMP (PARATYA COMPRESSA IMPROVISA) AS A SENSITIVE TEST ORGANISM TO PESTICIDES.
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.
S. Hatakeyama, and Y. Sugaya.
Environmental Pollution ENPOEK, Vol. 59, No. 4, p 325-336, 1989. 2 fig, 3 tab, 13 ref.

Descriptors: *Shrimp, *Insecticides, *Herbicides, *Water pollution effects, *Bioindicators, Bioassay, Toxicity, Paratya, Waterfleas.

The susceptibility of 2-week-old individuals of the freshwater shrimp, Paratya compressa improvisa, to five kinds of insecticide and five kinds of herbicide was examined in comparison with that of two species of Cladocera, Daphnia magna and Moina macrocopa. The shrimp was especially sensitive to two organophosphorus insecticides. The 48-hour LC50 values for fenitrothion and fenthion to the shrimp were 1.15 and 1.04 microgram/liter (mean value, n=2), in contrast with 37.8 and 35.3 microgram/ liter in the cases of M. macrocopa, and more that 50 microgram/liter with D. magna. The shrimp also showed the higher susceptibility to other insecticides, diazinon, carbaryl and 2-sec-butylphenyl N-methylcarbamate, apart from D. magna to diazinon and carbaryl. The shrimp also showed higher susceptibility to herbicides. The 48-hour LC50 values of chlornitrofen, benthiocarb, oxadiazon, butachlor, and symetryne to the shrimp were 2 to 8 times lower than those of two species of Cladocera, except for the LC50 value of oxadiazon, to M. macrocopa, which was very slightly higher. However, the shrimp showed a somewhat lower susceptibility to heavy metals than the two species of Cladocera, especially to copper, and to cadmium and zinc in comparison with D. magna. A bioassay using the shrimp with river water, collected from the river adjacent to the paddy field, showed clearly the high mortality of the shrimp following the aerial spraying with pesticides. (Author's abstract)
W90-02242

METHYL-, POLYMETHYL-, AND ALKYLPOLYCHLORODIBENZOFURANS INDENTIFIED IN PULP MILL SLUDGE AND SEDIMENTS.
Station Federale de Recherches en Arboriculture, Viticulture et Horticulture de Waedenswil (Switzerland).
H.-R. Buser, L.-O. Kjeller, S. E. Swanson, and C. Rappe.
Environmental Science and Technology ESTHAG, Vol. 23, No. 9, p 1130-1137, September 1989. 7 fig, 5 tab, 13 ref.

Descriptors: *Water pollution sources, *Water pollution effects, *Pulp and paper industry, Chemical analysis, Dibenzofurans, Furans, Dioxins.

A large number of methyl-, polymethyl-, and other alkylpolychlorodibenzofurans were identified in marine and fresh water sediments outside pulp mills. Previously, the same compounds were erroneously identified as polychloroxanthenes and polychloroxanthones. The compounds were present in sludge and sediments were concentration levels up to 1000 times higher than those of the polychlorodibenzodioxins and polychlorodibenzofurans. The highest levels were found for compounds having $x + y = 5$-7 (x is the number of methyl and y the number of chlorine substituents). The compounds could serve as markers for pulp bleaching activities. Interestingly, they seemed not to accumulate significantly in fish. Another study with a few isomers of the compounds of the nature identified here showed that these were effective antagonists of 2,3,7,8-tetrachlorodibenzodioxin toxicity; otherwise, their toxicological significance was unknown. The new compounds may interfere in polychlorodibenzodioxin and polychlorodibenzofuran analyses at values used to monitor (13-C12)-polychlorodibenzodioxin and (13-C12)-polychlorobenzofurans in high-resolution gas chromatography/low-resolution mass spectrometry analyses. High-resolution mass spectrometry could be used to distinguish the dimethyl-polychlorodibenzofurnas from the polychloroxanthones, but methylpolychlorobenzofurans and the polychloroxanthenes had the same elemental formulas and thus the same exact mass. Additional polychloro compounds were also present in sludge and sediments, but the corresponding methyl-polychlorodibenzodioxins and dimethyl-polychlorodibenzodioxins so

far had not been detected. A series of synthetic methyl-polychlorodibenzofurans and dimethyl-polychlorodifurans were analyzed, confirming these conclusions. (Author's abstract)
W90-02247

BACTERIOLOGICAL PARAMETERS AND BIOMONITORING OF WATERS: A COMPARISON OF SITES (BAKTERIOLOGISCHE PARAMETER UND BIOMONITORING VON GEWASSERN: EIN STANDORTVERGLEICH).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
H. D. Bebenzien.
Limnologica LMNOA8, Vol. 19, No. 2, p 131-145, 1988. 14 fig, 6 tab, 78 ref. English summary.

Descriptors: *Bacterial analysis, *Water analysis, *Bioindicators, *Monitoring, Rivers, Lakes, Water pollution, Velocity, Carbon radioisotopes.

The need to include bacteriological processes in the monitoring program has been determined from their pivotal role in aquatic ecosystems. Possible methods to quantify bacterial activities were demonstrated with special emphasis on the advantages of kinetic parameters. Heterotrophic potential (uptake rates of 14C-labelled glucose) was measured at several sites (river estuary and freshwater lake). Results suggest that maximum velocity may function as an indicator of relative pollution. Alterations of natural mineralization activity as a result of various stresses were also observed. Effects of thermal pollution by two nuclear power plants were analyzed in detail, and the application of the heterotrophic activity method in the study of stressed lakes is discussed. (Author's abstract)
W90-02253

MULTISPECTRAL REMOTE SENSING AS A FRESHWATER QUALITY SURVEILLANCE TOOL.
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
For primary bibliographic entry see Field 7B.
W90-02303

GROUND WATER MONITORING EVALUATION, HUGHES AIRCRAFT, U.S. AIR FORCE PLANT NO. 44, TUCSON, ARIZONA.
Environmental Protection Agency, Seattle, WA. Region X.
M. G. Filippini, and D. Zuroski.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-125405. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA-700-8-87-037, April 1988. 72p, 12 fig, 4 tab, 13 ref, 2 append.

Descriptors: *Groundwater pollution, *Water pollution control, Monitoring, Regulations, Heavy metals, Organic compounds, Arizona, Wells, Trichloroethene, Dichloroethene, Caprolactum, Hexanol, Hydrocarbons, Radium, Aquifers, Fate of pollutants, Radioisotopes.

The results of groundwater investigations conducted during April 1987 at the Hughes Aircraft/Air Force Plant No. 44 in Tucson, Arizona are summarized. Specific objectives of this investigation were: (1) to determine if the facility is in compliance with interim status groundwater monitoring requirements of 40 CFR Part 265 as promulgated under RCRA and the State equivalent; (2) to determine if the groundwater monitoring program described in the facility's RCRA Part B permit application complies with 40 CFT Part 270.14(c); (3) to determine if the groundwater at the facility contains hazardous waste constituents; (4) to determine if the groundwater monitoring system can immediately detect any statistically significant amounts of hazardous waste constituents that migrate from the waste management area to the uppermost aquifer underlying the facility; (5) to determine if Hughes has developed and is following an adequate plan and procedures for groundwater sampling and analysis; (6) to determine if the groundwater quality assessment program outline (or plan, as appropriate) is adequate; (7) to determine if recordkeeping and reporting procedures for groundwater monitoring are adequate; and (8) to identify active and inactive solid waste management units. Trichloroethene (TCE) and 1,1-dichloroethene (DCE) were found in most wells. The most heavily contaminated well, in addition to TCE and DCE, contained Caprolactum (20 parts per billion (ppb)), 1-hexanol, 2-ethyl (9 ppb) and two unknown hydrocarbons. Levels of metals and many indicator parameters were also higher than in surrounding regional aquifer wells. Radionuclide levels in the most heavily contaminated well were dramatically higher than all other wells sampled. Total radium was reported at 33 +/-4 pico-Curies (pCi)/L, gross alpha was reported at 180 +/-90 pCi/L, and gross beta was reported at 350 +/-90 pCi/L. These levels of radionuclides were two orders of magnitude higher than surrounding wells. It cannot be determined if these levels are naturally occurring or rereflect some unknown source. (Lantz-PTT)
W90-02307

MONITORING FOR ENVIRONMENTAL IMPACT.
Water Research Centre, Medmenham (England).
V. A. Cooper, and T. J. Lack.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 231-242, 6 fig, 1 tab, 9 ref.

Descriptors: *Wastewater disposal, *Sludge disposal, *Monitoring, *Water pollution effects, *Environmental effects, *Wastewater disposal, Ocean dumping, Marine environment, Computer models, Viruses, Bioassay.

Increasing environmental awareness means that the UK water industry must be in the forefront in assessing the effect of marine disposal of sewage and sludge if they wish to continue to benefit from this outlet. The Water Research center is currently involved in research into the effects of sewage and sludge disposal on the environment. The broad based studies include computer modeling for impact prediction, tracer studies, viral surveillance techniques, ecological impact and the monitoring of sub-lethal effects using field and laboratory bioassays. In addition there are studies aimed at producing guidelines for hydraulic and structural design of sea outfalls and quantifying the effectiveness of head works processes. Adverse effects detected in the field have been minimal, even using highly sensitive techniques. The importance of broad-based studies in such areas of minimal ecological impact is stressed. (See also W90-02317) (Author's abstract)
W90-02331

TOTAL ORGANIC HALIDE MEASUREMENTS.
Environmental Protection Agency, Cincinnati, OH. Risk Reduction Engineering Lab.
R. C. Dressman, and A. A. Stevens.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-124465. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/234, November 1988. 18p, 2 fig, 5 tab, 25 ref.

Descriptors: *Pollutant identification, *Halides, *Chemical analysis, *Water analysis, *Water quality control, *Monitoring, Organic compounds, Wastewater.

Measurements of surrogates and of specific compounds can be useful in assessing water quality. In some cases, analyses for specific chemical provide the required information. In other situations, however, individual halogen-containing chemicals cannot be measured easily or at all, and total organic halides (TOX) or nonpurgeable organic halides (NPOX) measurements are a useful indicator of chemical content. For a survey of possible organohalide contamination, OX measurements may be satisfactory as a prelude to more detailed analysis or simply as an early warning indicator. An important application of OX measurements is in unit process design, control, and monitoring. Measurement of OX in wastewater primarily discerns compounds of industrial origin, whereas analysis of OX in finished drinking water primarily discerns disinfection by-products. Trihalomethane and NPOX data generated under carefully controlled 'treatment' conditions can lead to a plant design that minimizes the formation, and thus the concentration, of halogenated disinfection by-products in the treated water. Halogenated by-products can be monitored and, to some extent, controlled in plant operation. From a health standpoint, minimizing these halogen-containing chemicals is assumed to be desirable, but in most cases an attempt is being made to control chemicals that cannot be directly measured. Many water samples have the potential for containing both disinfection by-products and industrial synthetic organics. Organohalide methods, being nonexclusive, have the hidden potential for biasing any attempted exclusive measure of either class of target organohalides. In spite of its shortcomings, the TOX method has a unique advantage in that it can verify the absence of OX contamination without the need to resort to a variety of specific methods to eliminate all the possibilities. Costs can be saved by using a single method to monitor a situation in which two or more methods might otherwise be required. To demonstrate the absence of either volatile organohalides or nonvolatile organohalides, measuring POX and NPOX can be used to similar advantage. (See also W90-02412) (Lantz-PTT)
W90-02427

GROUNDWATER QUALITY MONITORING AS A TOOL OF GROUNDWATER RESOURCES PROTECTION.
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
J. Vrba.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 88-97. 2 tab, 7 ref.

Descriptors: *Groundwater protection, *Water pollution prevention, *Monitoring, *Groundwater quality, *Karst, *Groundwater management, *Karst hydrology, Hydrologic data collections, Geology.

Groundwater quality monitoring is a complex process which provides data for groundwater protection management. Analysis and implementation of the data obtained from the relevant monitoring programs support the planning, strategy and policy for groundwater resources protection and quality conservation. The knowledge of effects of natural processes and anthropogenic activities on the groundwater system and the forecasting of trends in the groundwater quality in space and time is one of the main purposes of the monitoring process. High sensitivity of the hydrogeological system in karstic regions to the natural and human impacts and related peculiarities of monitoring methodology in karstic areas require special consideration. The design of a monitoring network and the number of monitoring stations in karstic areas is primarily influenced by: heterogeneity of the karstic structures; extreme variability of karstic rock's permeability; extensive cavity, cavern and channel systems especially in the upper part of the saturated zone; intensive physical (mechanical) and chemical (solutional) erosion; extensive recharge areas and concentrated discharge zone; turbulent conduit groundwater flow; high seasonal and long-term variability of groundwater level fluctuations and yields of springs; close interrelations between surface stream and groundwater flow; and a relatively short residence time of the groundwater in the karstic system. With a view to anthropogenic impacts the design of the monitoring network should consider the high vulnerability of most of the karstic systems, caused by the small thickness and low filtration capacity of the soil layer, especially in upland parts of the karst structure, and the low attenuation capacity of aquifer behavior. (See also W90-02444) (Author's abstract)
W90-02453

5B. Sources Of Pollution

METHODOLOGY FOR ASSESSMENT OF CONTAMINATION OF THE UNSATURATED ZONE BY LEAKING UNDERGROUND STORAGE TANKS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
F. A. DiGiano, C. T. Miller, A. C. Roche, and E. D. Wallingford.
Water Resources Research Institute of the University of North Carolina Report No. 242, November 1988. 71p, 29 fig, 11 tab, 36 ref. WRRI Project 70057.

Descriptors: *Fate of pollutants, *Underground storage, *Pollutant identification, *Monitoring, *Water pollution control, *Chemical analysis, Leachates, Aeration zone, Groundwater pollution, Volatile organic compounds, Nitrogen, Gas chromatography.

Three methods of measuring contamination of the partially saturated zone by leaking underground fuel tanks were investigated. Two of the methods relied upon obtaining a soil core from the field. These differed in the method of extraction: (1) by nitrogen purge of the entire core, followed by adsorption-solvent extraction and gas chromatographic (GC) analysis, and (2) by sonication of a small sub-sample from the core, followed by solvent extraction and GC analysis. The third method focused on saturation zone. This required use of a driveable ground probe (DGP) and activated carbon trap (to concentrate the contaminants), followed by solvent extraction and GC analysis. This research combined a laboratory study of the methods under controlled conditions, with field study at the Marine Corps Base Camp Lejeune. The soil core procedures required construction of a sampling tube that proved successful in the system upon return to the laboratory. Recoveries approaching 100% were achieved in the nitrogen purge procedure by: heating the soil core to 100 C; trapping water exiting the soil core prior to the adsorption step; and using activated carbon instead of Tenax as the adsorbent. Vapor phase measurements provided a convenient way to map the extent of contamination from a leaking underground gasoline storage tank at the Camp Lejeune site. Concentrations of target compounds ranged from 10,000 micrograms/L (ug/L) to < 10 ug/L of vapor phase. The highest concentrations were found above the non-aqueous--phase liquid (NAPL). However, the method was able to show that contamination exists well beyond the NAPL, although the concentrations drop off precipitously. (Lantz-PTT)
W90-01944

ENTERIC VIRUSES IN A MANGROVE LAGOON, SURVIVAL AND SHELLFISH INCIDENCE.
Puerto Rico Univ., Rio Piedras. Microbial Ecology Lab.
I. Lopez de Cardona, M. Bermudez, E. Billmore, and T. C. Hazen.
Caribbean Journal of Science CRJSA4, Vol. 24, No. 3/4, p 102-111, December 1989. 3 fig, 2 tab, 36 ref. Sea Grant R/LR-08-87-THA1, Public Health Service grants RR-2657 and RR-8102, and Department of Energy Contract DE-AC09-76SR00001.

Descriptors: *Water pollution sources, *Puerto Rico, *Enteroviruses, *Oysters, *Mangrove swamps, Lagoons, Tropical regions.

Mangrove oysters (Crassostrea rhizophorae) were screened for enteric viruses. For 18 months oysters were collected from Cano Boqueron, a tropical mangrove lagoon on the southwest coast of Puerto Rico. This popular resort has two primary sewage treatment plants which service 158 single-family cabanas. In spite of the heavy seasonal input of treated sewage to Cano Boqueron and high densities of fecal coliform bacteria, enteric viruses were not detected in shellfish meat. Because no viruses were detected in the oysters, a virus-survival study was performed. Poliovirus type I was placed in diffusion chambers in situ at two sites in Cano Boqueron. More than 95% of the poliovirus inactivation occurred within 24 hours. Chamber studies done simultaneously with Escherichia coli did not reveal differences between sites. Virus deactivation was significantly different by site, indicating different inactivation rates within the lagoon. It is suggested that the sewage effluent had an antiviral effect in the absence of an antibacterial effect. This study demonstrates the importance for establishing microbial contamination standards for shellfish-growing waters in the tropics based upon in-situ studies with tropical species. (Author's abstract)
W90-01947

DEVELOPMENTAL TOXICITY OF DICHLOROACETONITRILE: A BY-PRODUCT OF DRINKING WATER DISINFECTION.
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W90-01948

TERATOLOGY OF 2,3,7,8-TETRACHLORODIBENSO-P-DIOXIN IN A COMPLEX ENVIRONMENTAL MIXTURE FROM THE LOVE CANAL.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
For primary bibliographic entry see Field 5C.
W90-01949

MINOR AND MAJOR ELEMENTS IN SUSPENDED MATTER IN THE RHINE AND MEUSE RIVERS AND ESTUARY.
Nederlands Inst. voor Onderzoek der Zee, Texel.
R. F. Nolting, B. Sundby, and J. C. Duinker.
Netherlands Journal of Sea Research NJSRBA, Vol 23, No. 3, p 255-261, June 1989. 4 fig, 4 tab, 22 ref.

Descriptors: *Path of pollutants, *Trace metals, *Suspended solids, *The Netherlands, *Rhine-Meuse Rivers, Estuaries, Tidewater, Mixing.

The Rhine-Meuse system in The Netherlands discharge mainly through Nieuwe Waterweg. The average water discharge of the Rhine is 2500 cu m/s for a normal year, and the average suspended matter concentration is 25 mg/cu dm. The corresponding numbers for the Meuse are 250 cu m/s and 25 mg/cu dm. Surface water samples were collected at hourly intervals in the estuary over a complete tidal cycle. It was determined that suspended sediment in the Rhine-Meuse estuary contained as little as one third of the trace metal content of the river-borne suspended matter. It was shown that the strong seawardly decreasing gradient in the trace metal content of the suspended particulate matter is not due to desorption processes, but can be explained simply by the mixing of river-borne and marine-derived suspended sediments. (Author's abstract)
W90-01962

HIGH-LEVEL NUCLEAR WASTE MANAGEMENT: A GEOCHEMICAL PERSPECTIVE.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 5E.
W90-01983

TRACE METAL DISTRIBUTION IN SEDIMENTS AND BENTHIC FAUNA OF HAIFA BAY, ISRAEL.
Israel Oceanographic and Limnological Research Ltd., Haifa.
H. Hornung, M. D. Krom, and Y. Cohen.
Estuarine, Coastal and Shelf Science ECSSD3, Vol 29, No. 1, p 43-56, Jul 1989. 6 fig, 4 tab, 33 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Israel, *Trace metals, *Marine sediments, *Benthic fauna, Bays, Distribution patterns, Sedimentation.

Haifa Bay, although adjacent to major chemical and other industries, showed no significant contamination of Cu, Cd, Pb and Zn in the sediments or benthic biota except for one station opposite the polluted Kishon river estuary. There was moderate to low Hg contamination throughout the bay, derived from the outfall of a chlor-alkali plant. The levels of Hg in the surficial sediment and biota have not changed significantly over the last 7 years, a period when effluent treatment was operating at the chlor-alkali plant. Using pollutant laden particles from recognized point sources as tracers for sediment transport, it was concluded that the southern part of Haifa Bay is an area of net sedimentation. No sediment from this area was detected further north in the bay. Sediments introduced at the north of the bay spread both north and south. Within most of the bay there has been no major sediment accumulation or erosion over the past 7 years. (Author's abstract)
W90-01986

CHEMICAL SPECIATION OF DISSOLVED NICKEL, COPPER, VANADIUM AND IRON IN LIVERPOOL BAY, IRISH SEA.
Liverpool Univ. (England). Dept. of Oceanography.
For primary bibliographic entry see Field 2L.
W90-01987

ACID RAIN STUDY IN THE WASHINGTON, D.C. AREA.
Brookhaven National Lab., Upton, NY. Atmospheric Sciences Div.
A. A. N. Patrinos, M. J. Leach, R. M. Brown, R. L. Tanner, and F. S. Binkowski.
Journal of Applied Meteorology JAMOAX, Vol 28, No. 9, p 948-968, Sep 1989. 32 fig, 6 tab, 26 ref. EPA Contract 79-D-X0533 and U.S. Department of Energy Contract DE-AC02-76CH00016.

Descriptors: *Acid rain, *Path of pollutants, *Urban areas, *District of Columbia, Delaware valley, Nitrates, Sulfates.

A field study in the Washington, D.C. area explored the impact of urban emissions and mesoscale meteorology on precipitation chemistry. The study was a follow-up to an earlier, considerably more industrialized, study in the Philadelphia area; emissions along the Delaware Valley were found to affect the deposition of nitrate and sulfate on the urban mesoscale. The Washington studies were designed to complement and enhance the earlier study with an expanded sampling domain, sequential precipitation sampling and airborne measurements. Four storms were sampled successfully between October 1986 and April 1987. Results appear to confirm the conclusions of the Philadelphia study, although the upwind-downwind contrast in nitrate and sulfate deposition is not as pronounced. This difference is attributed to the area's widely distributed emission patterns and to the prevailing theories regarding the production of nitric acid and sulfuric acid on the relevant time and space scales. The importance of mesoscale meteorology and hydrogen peroxide availability is highlighted in at least two of the sampled storms. (Author's abstract)
W90-01992

MICROBIAL MINERALIZATION OF CHLORINATED PHENOLS AND BIPHENYLS IN SEDIMENT-WATER SYSTEMS FROM HUMIC AND CLEAR-WATER LAKES.
Lund Univ. (Sweden). Dept. of Ecology.
P. Larsson, and K. Lemkemeier.
Water Research WATRAG, Vol. 23, No. 9, p 1081-1085, 1989. 5 fig, 2 tab, 17 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Polychlorinated biphenyls, *Phenols, *Lakes, *Microbial degradation, Carbon radioisotopes, Mineralization, Humic lakes, Clear-water lakes, Chlorinated phenols, Biphenyls, Sediment-water interfaces.

The microbial mineralization of three chlorophenols and a PCB mixture was studied using natural bacterial assemblages in laboratory model systems. The systems consisted of water and surface sediment from two lake types: one with a high content of humic substances and the other with the low content. Aerobic mineralization of the C14-ring-

labelled compounds was determined as a production of C14O2 in the systems. The mineralization rates of 3,4-dichlorophenol and 2,4,5-trichlorophenol were higher in humic cultures whereas pentachlorophenol showed higher rates in clear-water cultures. Mineralization of PCBs in the system was low. Compared with microbial mineralization rates in cultures containing only lake water, the addition of sediment resulted in a decrease in dichlorophenol and trichlorophenol mineralization. Pentachlorophenol was mineralized at considerably higher rates in the presence of sediment. (Author's abstract)
W90-02005

PRODUCTION OF BROMINATED METHANES IN DESALINATION PLANTS IN KUWAIT.
Liverpool Univ. (England). Dept. of Oceanography.
For primary bibliographic entry see Field 5F.
W90-02007

E. COLI AND ENTEROCOCCI LEVELS IN URBAN STORMWATER, RIVER WATER AND CHLORINATED TREATMENT PLANT EFFLUENT.
Michigan Univ., Ann Arbor. Dept. of Environmental and Industrial Health.
J. J. Gannon, and M. K. Busse.
Water Research WATRAG, Vol. 23, No. 9, p 1167-1176, 1989. 1 fig, 5 tab, 27 ref.

Descriptors: *Urban runoff, *Water pollution sources, *Bioindicators, *Bacteria, *Coliforms, *Michigan, *Storm runoff, Huron River, Pathogens, Statistical analysis, Escherichia coli, Fecal streptococci, Monitoring.

Stormwater from the Ann Arbor, Michigan area affects the bacterial indicator organism quality of the Huron River. Investigations during the 1985 summer period involved sampling during dry and wet periods with parallel determinations for each sample for fecal coliforms, fecal streptococci, E. coli and enterococci. Wet weather bacterial indicator densities were statistically significantly higher than dry weather levels, and downstream densities were statistically significantly higher than upstream densities. The FC/FS (fecal coliform/fecal streptococci) ratios for the storm drains were low and suggestive of more animal than human sources. The geometric mean EC/FC (E. coli/fecal coliforms) ratios were in the range of 0.82-1.34, well above the ratio of 0.63 calculated using the U.S. EPA recommended level for E. coli of 126/100 ml to the presently accepted level for fecal coliforms of 200/100 ml. If the intent is to maintain the currently accepted illness rate, additional results from other areas are necessary to refine the E. coli and enterococci levels for water quality standard development purposes. In general, physical-chemical observations reflected the source of the sample. (Author's abstract)
W90-02015

OPTIMIZATION OF A SAMPLING DESIGN AND SIGNIFICANCE OF BACTERIAL INDICATORS: APPLICATION TO THE BACTERIOLOGICAL SURVEY OF THE ARDECHE RIVER, FRANCE.
Montpellier-2 Univ. (France). Lab. d'Hydrobiologie.
For primary bibliographic entry see Field 5A.
W90-02017

DISSIMILATORY NITRATE REDUCTION IN A WASTE-WATER CONTAMINATED AQUIFER.
STS Consultants Ltd., Minneapolis, MN.
P. A. Bulger, A. E. Kehew, and R. A. Nelson.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 664-671, 8 fig, 1 tab, 19 ref.

Descriptors: *Aquifers, *Nitrates, *Groundwater pollution, *North Dakota, *Path of pollutants, *Fate of pollutants, *Biodegradation, Infiltration, Groundwater chemistry, Organic carbon, Anaerobic bacteria, Leachates, Nitrate reduction, Ammonium.

Groundwater beneath the McVille, North Dakota Municipal Waste-Stabilization Ponds was studied to determine the chemical effects of seepage on a shallow unconfined aquifer. Relatively coarse-grained glaciofluvial sediments underlie the site and facilitate transport of partially treated waste water to the water table, altering the local groundwater chemistry. The plume resulting from infiltration contains elevated levels of dissolved organic carbon (DOC) and ammonium in areas of low redox potential. The presence of nutrients in waters of low redox potential promotes the growth of anaerobic bacteria. Groundwater containing high nitrate concentrations, due to the leachate from an adjacent abandoned landfill, occurs upgradient of the ponds. These high nitrate waters, traveling downgradient, mix with the low redox potential groundwater beneath and downgradient of the lagoon. Ammonium concentrations, downgradient of the waste-stabilization ponds, are greater than ammonium levels within the ponded wastewater. The abundant microbial population appears to utilize DOC and nitrate as nutrients for growth and energy. The utilization of nutrients occurs in a redox reaction, in which nitrate is apparently reduced to ammonium and carbon is oxidized. The increase in ammonium levels and decrease in nitrate levels suggests nitrate is not assimilated into the cell tissue, but instead dissimilatory nitrate reduction to ammonium takes place. Dissimilatory reduction refers to reduction of a compound for its energy yield, without conversion of the compound to biomass. (Author's abstract)
W90-02024

MODELING TRANSPORT OF A DEGRADABLE CHEMICAL AND ITS METABOLITES IN THE UNSATURATED ZONE.
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 2F.
W90-02025

TEMPORAL AND METAL-SPECIFIC PATTERNS IN THE ACCUMULATION OF HEAVY METALS BY THE SCALES OF FUNDULUS HETEROCLITUS.
South Carolina Univ., Columbia. Marine Science Program.
G. R. Sauer, and N. Watabe.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 233-248, April 1989. 4 fig, 3 tab, 43 ref.

Descriptors: *Heavy metals, *Fish physiology, *Killifish, *Path of pollutants, *Bioaccumulation, *Zinc, Calcium, Manganese, Lead, Strontium, Fish scales, Fundulus, Monitoring.

X-ray microanalysis (XMA) was utilized to measure the zinc/calcium ratios in individual scales from Fundulus heteroclitus with different histories of exposure to Zn (10 mg/L). Circuli which formed during Zn-exposure contained high Zn/Ca ratios compared to those forming under 'metal-free' conditions. Since circuli form sequentially as the scale grows, scale Zn/Ca profiles constructed by XMA of each circulus in a scale provide a record of temporal variation in Zn exposure. Fish showed some ability to partially remove Zn from previously deposited scale tissue but Zn signatures remained for at least 16 weeks after transfer to metal-free water. The results indicate that teleost scales may be useful as continuous recorders of environmental metal exposure: the elemental composition of each circulus reflecting that of the environment at the time the circulus formed. When mixtures of metal chlorides were tested, Zn, Mn, Pb, and Sr were the metals most readily accumulated by F. heteroclitus scales while Cd and Cu showed little or no accumulation. The ability of fish scales to accumulate heavy metals has the potential for application to environmental monitoring, population identification, and age determination. (Author's abstract)
W90-02031

EFFECTS OF SITE VARIATIONS ON SUBSURFACE BIODEGRADATION POTENTIAL.
CH2M/Hill, Corvallis, OR.
G. T. Hickman, J. T. Novak, M. S. Morris, and M. Rebhun.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1564-1575, September 1989. 14 fig, 5 tab, 42 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Groundwater pollution, *Biodegradation, *Microorganisms, *Soil contamination, Organic compounds, Metabolic inhibitors, Nitrites, Nitrates, Sulfates, Methanogenesis, Soil organic matter, Methanol, Tertiary butyl alcohol.

Biodegradation rates for several organic contaminants, primarily methanol and tertiary butyl alcohol (TBA), in static microcosms containing subsurface soil from eight sampling locations were compared. Biodegradation rates were evaluated under ambient anoxic conditions and in the presence of added potential electron acceptors (NO3(-), NO2(-), SO4(2-)) or metabolic inhibitors (2-bromoethanesulfonic acid (BESA), MoO4(2-)) to promote different pathways of microbial catabolism (denitrification, sulfate reduction, or methanogenesis). Biodegradation rates varied substantially between sites; the various chemical amendments affected biodegradation rates differently in soils from different sites. The results indicate that the studied sites can be categorized into two general types. 'Fast' soils are characterized by a higher flux of water and nutrients, higher biodegradation rates, and rate enhancement with the addition of nitrate or sulfate. In 'slow' soils, organic contaminants are degraded at lower rates, rates are decreased by adding NO3(-), SO4(2-), or BESA, and rates are increased by adding MoO4(2-). These results demonstrate the necessity for understanding the nature of the microbial community and important metabolic pathways when conducting risk assessment, formulating remedial actions, or attempting to stimulate the biodegradation in contaminated subsurface systems. (Author's abstract)
W90-02106

CONTRIBUTION OF AMMONIA EMISSIONS FROM AGRICULTURE TO THE DEPOSITION OF ACIDIFYING AND EUTROPHYING COMPOUNDS ONTO FORESTS.
Utrecht Rijksuniversiteit (Netherlands). Dept. of Physical Geography.
G. P. J. Draaijers, W. P. M. F. Ivens, M. M. Boss, and W. Bleuten.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 55-66, 1989. 2 fig, 3 tab, 36 ref.

Descriptors: *Farm wastes, *Manure, *Acid rain, *Ammonia, *Sulfates, *Forests, *Eutrophication, Emissions, Acidification, Throughfall, Stemflow, Bulk precipitation, Agriculture, Synergistic effects, Model studies, Correlation analysis.

In the vicinity of a large ammonia emission area, dry and wet deposition of acidifying and eutrophying compounds onto Douglas Fir forests was studied by sampling throughfall, stemflow and bulk precipitation. Deposition amounts of NH(4+) and SO4(2-) were recognized to be among the highest of Central Europe, resulting in extremely high inputs of (potential) acid to the forest soils (13.1 k Eq/ha/year). The contribution of NH3 emissions from agriculture to the total acid deposition to the forests was 52%. The total nitrogen deposition amounted to 115.0 kg/ha/year, 83% originating from NH3 emissions and 17% from NOx emissions. Calculated mean dry deposition velocities of NH3 and SO2 were much larger than reported in the literature. In addition, throughfall measurements indicate an interaction between NH3 and SO2 in the process of dry deposition. When all sample periods are considered separately, a very high correlation exists between the NH4(+) and the SO4(2-) throughfall flux. The interaction between NH3 and SO2 in the process of dry deposition results in the formation of (NH4)2SO4 on the tree surface. When deposition models do not take this interaction into account, they will underestimate NH3 and SO2 deposition amounts in areas with intensive animal husbandry. (White-Reimer-PTT)
W90-02114

UPTAKE OF CADMIUM AND ZINC BY THE ALGA CHLORELLA VULGARIS: PART 1. INDIVIDUAL ION SPECIES.
Monash Univ., Clayton (Australia). Dept. of Chemical Engineering.
Y. P. Ting, F. Lawson, and I. G. Prince.
Biotechnology and Bioengineering BIBIAU, Vol. 34, No. 7, p 990-999, October 5, 1989. 8 fig, 2 tab, 24 ref.

Descriptors: *Chlorella, *Chemical speciation, *Path of pollutants, *Mathematical models, *Mathematical models, *Bioaccumulation, *Heavy metals, *Algae, Chlorophyta, Cadmium, Zinc, Bacteria, Cations.

A quantitative mathematical model for the uptake by algae and bacteria of heavy metals from the surrounding environment was developed. The model postulates two mechanisms: an initial rapid metal ion uptake due to attachment onto the cell wall followed by a relatively slow uptake due to membrane transport of the metal into the cell. The mathematical model was tested using the alga Chlorella vulgaris in the presence of either cadmium or zinc in solution under various experimental conditions. When the cells were resuspended in fresh growth medium, the uptake of cadmium was rapidly reversed while the uptake of zinc was not. The model may be applicable to the uptake of both essential and nonessential elements, although the extent of metal accumulation would be dependent on the necessity of metal ion for cellular functions. (Ence-PTT)
W90-02126

THREATS TO THE WORLD'S WATER.
International Council of Scientific Unions, Paris (France).
For primary bibliographic entry see Field 6D.
W90-02132

POLYCYCLIC AROMATIC HYDROCARBONS IN SACCOGLOSSUS KOWALEWSKYI (AGASSIZ).
Wesleyan Univ., Middletown, CT. Dept. of Earth and Environmental Sciences.
D. A. Carey, and J. W. Farrington.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 29, No. 2, p 97-113, Aug 1989. 6 fig, 2 tab, 45 ref.

Descriptors: *Oil pollution, *Polycyclic aromatic hydrocarbons, *Macroinvertebrates, *Marine sediments, Tissue analysis, Steroids, Alkanes, Cape Cod, Massachusetts.

Hydrocarbon extracts were analyzed from Saccoglossus kowalewskyi, a deposit-feeding enteropneust worm, and from surface sediments from Cape Cod, MA. Worms were held in experimental aquaria in sieved sediments and flowing seawater for four months and then fed sediments mixed with creosote, lampblack or clean sediment for two weeks as analogues of sediments containing degraded oil and pyrogenic compounds. Worms from all treatments contained polyaromatic hydrocarbons (PAHs) in amounts and composition that indicate that the worms were contaminated with weathered No. 2 fuel oil before our experimental treatment and that the contamination persisted for four months in clean conditions. The contamination was not detected in the clean sediments used in the experiment. The worms accumulated steroid transformation products in greater abundance than the odd chain n-alkanes that dominated the sediment extractions. This may indicate selective assimilation of algal detritus and microbial products over salt marsh detritus. Worms, actively feeding during the experiment, contained 1-3 x .000001g/g dry weight of unknown brominated compounds which were not detected in the sediments. These compounds are similar to bromopyrroles found elsewhere in enteropneusts, polychaetes and bacteria and may cause substantial interference in analyses for some industrial pollutants. (Author's abstract)
W90-02136

ESTUARINE ECOLOGY OF PHENANTHRENE-DEGRADING BACTERIA.
New Hampshire Univ., Durham. Dept. of Microbiology.
W. J. Guerin, and G. E. Jones.
Estuarine, Coastal and Shelf Science ECSSD3, Vol 29, No. 2, p 115-130, Aug 1989. 7 fig, 3 tab, 49 ref. DOC Grant No. NA-81-AA-D-00035.

Descriptors: *Biodegradation, *Fate of pollutants, *Estuaries, *Marine bacteria, *Microbial degradation, Polycyclic aromatic hydrocarbons, Phenanthrene, Physiological ecology.

Phenanthrene degrading bacteria were ubiquitously distributed in the waters and sediments of the Great Bay Estuary, NH, as determined using a 14C-phenanthrene mineralization assay. Similar activities were observed in water samples collected in March and June when these were incubated at 18 degrees C even though ambient water temperatures were 1-4 degrees C and 10-22 degrees C, respectively. This observation indicated the constant presence of a mesophilic phenanthrene-degrading bacterial population in the estuary. Among water samples, the highest biodegradation activities were associated with samples collected downstream from a dredging operation which introduced high concentrations of coal tar PAH (polycyclic aromatic hydrocarbons) into the Cocheco River, and in areas receiving PAH from pleasure and commercial boating activities. Mid-estuarine maxima in biodegradation activity during both sampling trips suggested adaptation of the microbial flora to the salinities prevailing in the low turnover, high residence time portion of the Estuary at the time of sampling. Despite the hydrophobicity of phenanthrene, no correlation between biodegradation rates and particulate matter concentrations were observed. Similarly, concentrations of nutrients and dissolved and particulate organic matter correlated poorly with biodegradation rates. Better agreements between 14C-phenanthrene mineralization potentials and plate counts on a phenanthrene/toluene agar (PTA) medium were observed. Phenanthrene biodegradative activities and numbers of culturable bacteria growing on PTA were governed by the degree of previous exposure to PAH. (Author's abstract)
W90-02137

ESTIMATION OF SULFUR AND NITROGEN WET DEPOSITION TO THE GREAT LAKES.
Atmospheric Environment Service, Downsview (Ontario).
E. C. Voldner, and M. Alvo.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1223-1232, Oct 1989. 9 fig, 11 tab, 21 ref.

Descriptors: *Acid rain, *Great Lakes, *Network design, Sulfur, Nitrogen, Estimating.

Networks in the Great Lakes basin were evaluated with respect to their ability to determine annual wet deposition of sulfur and nitrogen and to detect temporal and spatial changes in deposition to the lakes and basins over the years 1980-1984. The effect of the redesign of the Great Lakes Atmospheric Deposition (GLAD) network was also studied. Two methods based on kriging were used to estimate the deposition. Annual sulfur deposition to Lake Superior was 30-40 kilotons in 1983. The estimates based on the major networks, special networks, or combinations thereof are not significantly different, although the differences amount to 25%. Hence, based on the reported data, the closure of GLAD sites is justifiable. Comparison between estimates obtained with the two methods reveals little difference for the major networks, while results for the special networks differ by more than 50%. The study points to the necessity of using standardized procedures when estimating deposition and to the need for over-water measurements. (Author's abstract)
W90-02139

BEHAVIOR OF THE INSECTICIDES DISULFOTON AND THIOMETON IN THE RHINE RIVER: A CHEMODYNAMIC STUDY.
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
O. Wanner, T. Egll, T. Fleischmann, K. Lanz, and P. Reichert.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1232-1242, Oct 1989. 8 fig, 3 tab, 29 ref.

Descriptors: *Path of pollutants, *Insecticides, *Organophosphorus pesticides, *Rhine River, Model studies, Disulfoton, Thiometon.

Model calculations and laboratory experiments were carried out to assess the dynamic behavior of the two insecticides disulfoton and thiometon in the Rhine River. Dilution, longitudinal dispersion, and biotransformation were found to be the dominant processes in determining the concentration-time course of the two compounds after their accidental release into the Rhine River at Schweizerhalle in November 1986. Biotransformation and, for summer conditions, also abiotic hydrolysis and oxidation by singlet oxygen are the important processes for reduction of the total load of disulfoton and thiometon in the Rhine River. For the conditions prevailing after the accident and a flow distance of 700 km, which corresponds to a travel time of 8 days, a reduction of the peak concentration of 97-98%, but a reduction of the total load of only approximately 50% is predicted for both compounds. Model predictions of the concentration-time courses of disulfoton and thiometon show favorable agreement with field measurements carried out at various sampling stations after the accident at Schweizerhalle. (Author's abstract)
W90-02140

INTERLABORATORY METHODS COMPARISON FOR THE TOTAL ORGANIC CARBON ANALYSIS OF AQUIFER MATERIALS.
Northrop Services, Inc., Ada, OK.
For primary bibliographic entry see Field 2F.
W90-02141

BIOGEOCHEMICAL PROCESSES AFFECTING ARSENIC SPECIES DISTRIBUTION IN A PERMANENTLY STRATIFIED LAKE.
Institut de Biogeochimie Marine, Montrouge (France).
P. Seyler, and J. M. Martin.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1258-1263, Oct 1989. 4 fig, 3 tab, 47 ref.

Descriptors: *Path of pollutants, *Arsenic, *Lakes, Stratification, Oxidation-reduction potential, France.

Arsenic species, iron, and manganese distributions were studied in the oxidizing and reducing waters of Lake Pavin, a small and well-stratified crater lake situated in the Massif Central range (France). Arsenate and arsenite concentrations versus depth to not reflect the expected thermodynamic equilibria, indicating a slow and incomplete response to the redox conditions. The occurrence of arsenic in the anoxic zone results from transport on a particulate phase, due to adsorption onto iron and manganese oxides and probably to incorporation in phytoplanktonic organisms. (Author's abstract)
W90-02142

USE OF MULTIVARIATE ANALYSIS FOR DETERMINING SOURCES OF SOLUTES FOUND IN WET ATMOSPHERIC DEPOSITION IN THE UNITED STATES.
Geological Survey, Doraville, GA.
R. P. Hooper, and N. E. Peters.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1263-1268, Oct 1989. 9 fig, 3 tab, 18 ref.

Descriptors: *Water pollution sources, *Chemistry of precipitation, *Multivariate analysis, *Water pollution sources, *Acid rain, Principal component analysis, Regression analysis.

A principal-components analysis was performed on the major solutes in wet deposition collected from 194 stations in the United States and its territories. Approximately 90% of the components derived

could be interpreted as falling into one of three categories--acid, salt, or an agricultural/soil association. The total mass, or the mass of any one solute, was apportioned among these components by multiple linear regression techniques. The use of multisolute components for determining trends or spatial distribution represents a substantial improvement over single-solute analysis in that these components are more directly related to the sources of the deposition. The geographic patterns displayed by the components in this analysis indicate a far more important role for acid deposition in the Southeast and intermountain regions of the United States than would be indicated by maps of sulfate or nitrate deposition alone. In the Northeast and Midwest, the acid component is not declining at most stations, as would be expected from trends in sulfate deposition, but is holding constant or increasing. This is due, in part, to a decline in the agriculture/soil factor throughout this region, which would help to neutralize the acidity. (Author's abstract)
W90-02143

INFLUENCE OF MACROMOLECULES ON CHEMICAL TRANSPORT.
Robert S. Kerr Environmental Research Lab., Ada, OK.
C. G. Enfield, G. Bengtsson, and R. Lindqvist.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1278-1286, Oct 1989. 8 fig, 2 tab, 43 ref. Swedish Natural Science Research Council (Grant No. G-GU-RT 1613-107), National Swedish Environmental Protection Board (Grant No. 5336064-0).

Descriptors: *Groundwater pollution, *Path of pollutants, *Solute transport, *Soil chemistry, *Molecular structure, Interstitial water.

Macromolecules in the pore fluid influence the mobility of hydrophobic compounds through soils. This study evaluated the significance of macromolecules in facilitating chemical transport under laboratory conditions. Partition coefficients between 14C-labeled hexachlorobenzene and three macromolecules (dextran, humic acid, and groundwater dissolved organic carbon (DOC)) were determined in a three-phase (water-macromolecule-soil) system. There were significant differences between the macromolecule:water partition coefficients, which ranged from 1000 to 1,000,000. Soil:water partitioning for humic acid was demonstrated by using column breakthrough curves where the breakthrough curve for humic acid was retarded behind 3H2O. Breakthrough curves for dextran and groundwater DOC demonstrated apparent size exclusion, as these compounds eluted from the soil column before the 3H2O. The impact of the dextran was demonstrated under dynamic conditions by use of hexachlorobenzene, anthracene, and pyrene with and without macromolecules in replicated, biologically inhibited (sodium azide), saturated soil columns. The results may help explain the mechanism by which hydrophobic pollutants appear in deep groundwater aquifers. (Author's abstract)
W90-02144

EFFECT OF SUSPENDED SEDIMENT CONCENTRATION ON THE SEDIMENT TO WATER PARTITION COEFFICIENT FOR 1,3,6,8-TETRACHLORODIBENZO-P-DIOXIN.
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
M. R. Servos, and D. C. G. Muir.
Environmental Science and Technology ESTHAG, Vol 23, No. 10, p 1302-1306, Oct 1989. 4 fig, 1 tab, 32 ref.

Descriptors: *Suspended sediments, *Dioxins, *Sediment-water interfaces, *Path of pollutants, *Solute transport, Centrifugation, Headspace analysis, Carbon radioisotopes, Partition coefficients, Comparison studies.

The sediment to water partition coefficient (Kp) for 1,3,6,8-tetrachlorodibenzo-p-dioxin was determined for suspended sediment concentrations ranging over 4 orders of magnitude. The truly dissolved (free) concentrations were estimated by four different methods: centrifugation at 6000g for 15 min, centrifugation at 20000g for 30 min, reverse-phase C18 cartridges, and dynamic headspace analysis. Centrifugation at either 6000g or 20000g resulted in a negative relationship between log Kp and log (suspended sediment concentration) (SSC) (i.e., slopes of -1.46 and -1.54), but both the C18 cartridge and dynamic headspace methods resulted in significantly less negative slopes (-0.46, -0.65). Dissolved organic carbon inflated the apparent free water concentrations, leading to an underestimation of Kp. However, measuring the truly dissolved concentrations did not completely eliminate the negative correlation between log Kp and log (SSC). Another mechanism such as particle interaction or methodological bias may explain the deviation from zero slope predicted by a linear two-phase sorption equilibrium. (Author's abstract)
W90-02145

NATURALLY OCCURRING PROTEINS FROM POND WATER SENSITIZE HEXACHLOROBENZENE PHOTOLYSIS.
Bayreuth Univ. (Germany, F.R.). Chair of Ecological Chemistry and Geochemistry.
M. Hirsch, and O. Hutzinger.
Environmental Science and Technology ESTHAG, Vol. 23, No. 10, p 1306-1307, Oct 1989. 1 tab, 10 ref.

Descriptors: *Fate of pollutants, *Hexachlorobenzene, *Proteins, *Amino acids, *Nitrogen compounds, Photolysis, Surface water, Path of pollutants, Transformation products.

Photolysis of hexachlorobenzene (HCB) in aqueous solution was conducted with several naturally occurring substances as sensitizer. The reaction rate was increased especially by aromatic amines such as tryptophan and diphenylamine. The photolysis rate of HCB is increased by at least 1 order of magnitude by all nitrogen compounds investigated. Tryptophan functions as a sensitizer for HCB even at the low concentrations that exist in natural surface waters. Dissolved proteins may play an important role in sensitizing the photolytic degradation of HCB in aqueous systems. The only transformation product detected, PCBz, does not account for all the loss of HCB in the photolysis experiments. Another possible product could be pentachlorophenol, whose photolytic half-life in aqueous systems is too short to be detectable. (Author's abstract)
W90-02146

DEPOSITION OF ATMOSPHERIC POLLUTANTS ON FORESTS.
Institute of Terrestrial Ecology, Edinburgh (Scotland).
D. Fowler, J. J. Cape, and M. H. Unsworth.
Proceedings of the Royal Society of London. Series B, Biological Sciences PRLBA4, Vol. 324, No. 1223, p 247-265, August 31, 1989. 8 fig, 7 tab, 46 ref.

Descriptors: *Acid rain, *Path of pollutants, *Air pollution, *Forest watersheds, *Sulfur, *Nitrogen, Elevation, Afforestation, England, Deposition, Reforestation.

Forests have long been considered as efficient sinks for atmospheric pollutants. The potential for large rates of deposition is provided by the turbulent structure of air above and within forest canopies. Large rates of deposition of pollutant gases, however, are only found for the very reactive gases HNO3, HCl and NH3. In contrast, the pollutants SO2 and O3 are deposited on forests and short vegetation at similar rates under the control of stomatal resistance. Deposition of sub-micrometer aerosol particles on forests appears to be inefficient but at high elevations in the United Kingdom (up to 500m) these aerosols are frequently activated into cloud droplets in the size range 5-10 micrometers (radius). These droplets are efficiently captured by forest canopies and this deposition pathway may make a large contribution to annual inputs at high elevation sites. The effects of afforestation on inputs of pollutants to catchments are illustrated by model calculations for inputs of sulphur and nitrogen to Kielder forest in northern England. Inputs of sulphur and nitrogen to this area as moorland are estimated at 17.5kg/ha (1 hectare = 10000 sq m) and 12.4kg/ha annually, respectively. Afforestation of the moorland increases sulphur and nitrogen inputs by 30% and 90% respectively. (Author's abstract)
W90-02148

EFFECTS OF ACID FOG AND DETERGENTS ON FOLIAR LEACHING OF CATIONS.
Florence Univ. (Italy). Dipt. di Biologia Vegetale.
E. Paoletti, R. Gellini, and E. Barbolani.
Water, Air and Soil Pollution WAPLAC, Vol. 45, No. 1-2, p 49-61, May 1989. 10 tab, 57 ref.

Descriptors: *Acid rain, *Acidic soils, *Air pollution, *Vegetation effects, *Trees, Leaching, Cations, Surfactants, Copper, Aluminum, Iron, Manganese, Calcium, Magnesium, Lead, Sodium, Potassium, Cadmium, Toxicity.

Relative rates of nutrient leaching from the epygeous apparatus of Quercus ilex L., Fagus sylvatica L., Acer opalus Mill., Euonymus japonicus L. and Phaseolus vulgaris L. were examined after exposure to simulated acid fog. Copper, Al, Fe, Mn, Ca, Mg and Pb were preferentially leached at low pH, whereas leaching rates of Na, K, and Cd did not appear to be pH-influenced. Addition of surfactant to the spray solutions showed a slight reduction of leaching for all elements investigated. Except for Mg, foliar nutrient levels were not influenced during the experiments. When leached foliar elements reach the soil, they can be leached through the soil or adsorbed to the soil particles and then reabsorbed by plants. Among the effects of acid deposition are injuries to roots, to mycorrhiza, and inhibition of litter mineralization. These are phenomena which could lessen the efficiency of leached element recycling, worsening nutrient scarcity with consequent reduction in vitality, higher receptivity to weak parasites and less resistance to drought. Since the elements more strongly leached due to acid deposition are Mn, Cu, Al, and Pb, toxicity phenomena can arise if significant quantities of these elements are in the soil. (White-Reimer-PTT)
W90-02158

SELENATE REDUCTION TO ELEMENTAL SELENIUM BY ANAEROBIC BACTERIA IN SEDIMENTS AND CULTURE: BIOGEOCHEMICAL SIGNIFICANCE OF A NOVEL, SULFATE-INDEPENDENT RESPIRATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-02168

RELATION BETWEEN AEROMONAS AND FAECAL COLIFORMS IN FRESH WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W90-02175

SEASONAL VARIATION OF POLLUTION INDICATORS IN A WILDFOWL RESERVE (DONANA NATIONAL PARK, SPAIN).
Centro de Investigaciones Biologicas, Madrid (Spain).
For primary bibliographic entry see Field 5A.
W90-02176

MOVEMENT OF PHOSPHATE IN A CATCHMENT WITH A SHALLOW EPHEMERAL WATER TABLE.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia).
R. G. Gerritse, and N. J. Schofield.
Journal of Contaminant Hydrology JCOHE6, Vol. 4, No. 4, p 313-331, September 1989. 9 fig, 6 tab, 15 ref.

Descriptors: *Eutrophication, *Water pollution sources, *Fertilizers, *Phosphates, *Model studies, Australia, Agricultural chemicals, Mathematical

models, Catchment areas, Path of pollutants, Leaching, Chlorides, Rainfall-runoff relationships.

The variation of phosphate over a period of five years in drains of two paired catchments was compared with the variation calculated with a one dimensional numerical model. The catchments are situated in the Karinga Downs in the south west of Western Australia and consist of sandy soils with a very low capacity to adsorb phosphate. Both catchments had been fertilized with phosphate for more than 15 years. Fertilization was continued in one catchment, while the other was left to 'run down'. Hydrological parameters for the simulation model were obtained from a combined analysis of runoff-rainfall relationships and chloride fluxes. Kinetic parameters describing the distribution of phosphate in the soils were available from a previous study. The calculated average trend of phosphate in the drains of the catchment with no fertilizer input is in good agreement with field observations. Results show that, even in weakly adsorbing sandy soils, substantial delays can occur in the response of a catchment to changes in P input. (Author's abstract)
W90-02181

SOIL POLLUTION BY PETROLEUM PRODUCTS, I. MULTIPHASE MIGRATION OF KEROSENE COMPONENTS IN SOIL COLUMNS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
A. J. Acher, P. Boderie, and B. Yaron.
Journal of Contaminant Hydrology JCOHE6, Vol. 4, No. 4, p 333-345, September 1989. 3 fig, 4 tab, 15 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Oil pollution, *Soil contamination, Kerosene, Volatility, Adsorption, Soil water, Path of pollutants.

A laboratory study was conducted of soil contamination by a synthetic 'kerosene'. Soil (Mediterranean red sandy clay) samples with different moisture contents (0.0, 0.8, 4.0, and 12%, w/w) were contaminated by vapors and/or liquid from a mixture containing five kerosene components (m-xylene, pseudo cumene, t-butylbenzene, n-decane and n-dodecane). The contribution of the different kerosene components to the adsorption, volatilization and transport processes was investigated. Vapor adsorption was dependent on the vapor concentration of each component (except for the n-decane), and on the soil moisture content. The sorption coefficients of the kerosene components decreased with increasing temperature but showed only a very slight variability between 20 and 34 C, in air-dried soil. The volatilization from soil was high: more than 90% of the aromatic components were desorbed in less than 2 h. The transport of the kerosene, in liquid and vapor phases, through the soil columns, was studied using amounts of kerosene which were less (1 ml) or more (10 ml) than the retention capacity of the soil columns. An increase in the moisture content of the soil increased the rate and the depth of the downward penetration of the kerosene. However, the increased soil moisture stopped the vapor movement (at 4%) and the upward liquid movement (at 12%). Among the properties of the kerosene components, volatility seems to be the prime factor which determines kerosene movement once liquid phase movement has ceased. (Author's abstract)
W90-02182

SOIL POLLUTION BY PETROLEUM PRODUCTS, II. ADSORPTION-DESORPTION OF 'KEROSENE' VAPORS ON SOILS.
Agricultural Research Organization, Bet-Dagan (Israel). Volcani Center.
B. Yaron, P. Sutherland, T. Galin, and A. J. Acher.
Journal of Contaminant Hydrology JCOHE6, Vol. 4, No. 4, p 347-358, September 1989. 5 fig, 4 tab, 20 ref.

Descriptors: *Path of pollutants, *Soil contamination, *Kerosene, Soil water, Adsorption, Soil types.

Adsorption and desorption of vapor hydrocarbons from a synthetic 'kerosene' source on different soils was studied. The 'kerosene' used consisted of a mixture containing 20% aromatic components (m-xylene, n-butylbenzene, pseudo-cumene) and 80% aliphatic components (n-decane, n-dodecane). Three different types of soils were used: Mediterranean red sandy clay, arid brown loessial silty loam and Evesham clay. The most influential parameter in the adsorption-desorption processes was the moisture content, which was examined over a range from oven dry to minus 1 bar water pressure (70% field capacity). The highest adsorption values were on the arid brown loessial silty loam soil, having the following order of adsorption: n-decane > m-xylene > pseudo-cumene > n-butylbenzene > n-dodecane. Among the 'kerosene' components the fastest desorption rate was exhibited by m-xylene and the slowest by n-dodecane, in all the soils studied. (Author's abstract)
W90-02183

FIELD RESEARCH STUDIES ON THE MOVEMENT AND DEGRADATION OF THIODICARB AND ITS METABOLITE METHOMYL.
Rhone-Poulenc Ag Co., Research Triangle Park, NC.
R. L. Jones, T. W. Hunt, F. A. Norris, and C. F. Harden.
Journal of Contaminant Hydrology JCOHE6, Vol. 4, No. 4, p 359-371, September 1989. 7 tab, 9 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Pesticides, *Soil contamination, *Degradation, *Insecticides, *Groundwater pollution, Monitoring, Thiodicarb, Methomyl.

The movement and degradation of thiodicarb and its metabolite methomyl were measured at three locations in the U.S. At a site near Clayton, North Carolina, soil samples were used to determine the degradation rate of thiodicarb in surface soils and methomyl in both surface and subsoils. At sites near Palermo, New York, and Oviedo, Florida, the shallow groundwater was monitored following multiple foliar applications of thiodicarb. These groundwater monitoring studies were conducted under conditions favorable to movement of pesticides to groundwater since surface soils were loamy sand or sand, subsoils were sand, water tables ranged between 0.1 and 1.8m, and rainfall was supplemented by irrigation to ensure that the sum of irrigation and rainfall was at least 1.5 times the normal monthly rainfall. In these studies the half-life of thiodicarb was only a few hours in surface soils, while the half-life of methomyl was about two days in surface soils and about 0.5 to 1.6 months in subsoils. Although methomyl residues were detected in shallow groundwater in the Oviedo and Palermo studies (designed to be representative of worst case situations), these residues were present in only one well cluster and one sampling interval, and at concentrations substantially below the established health advisory level. (Author's abstract)
W90-02184

EXPERIMENTAL DETERMINATION OF THREE-FLUID SATURATION PROFILES IN POROUS MEDIA.
Princeton Univ., NJ. Dept. of Civil Engineering and Operations Research.
L. A. Ferrand, P. C. D. Milly, and G. F. Pinder.
Journal of Contaminant Hydrology JCOHE6, Vol.4, No. 4, p 373-395, September 1989. 9 fig, 3 tab, 15 ref. NSF grant ECE-8501649 and Department of Energy grant DE-AC02-83ER60170.

Descriptors: *Groundwater movement, *Saturation, *Multiphase flow, *Path of pollutants, *Laboratory methods, *Porous media, Pollutant transport.

A method for nondestructively measuring local saturations with respect to multiple fluids is required for laboratory investigations of separate phase transport in porous media. The distribution of up to three fluids in a medium whose porosity is independent of changes in fluid content may be determined using the dual-gamma (137 Cs-241 Am) technique. A calibration technique is proposed that permits calculation of porosity and relative saturations from gamma attenuation data for porous media which are initially saturated with a single fluid. This technique may be used to determine the distribution of each fluid within the medium as well as it bulk fluid content. Porosity and saturation profiles measured for sand samples containing air, water and trichloroethylene or perchloro-ethylene demonstrate the potential of the method for use in steady-state laboratory studied. (Peters-PTT)
W90-02185

CHANGES IN THE CHEMICAL COMPOSITION OF STREAM WATER IN TWO CATCHMENTS IN THE SHENANDOAH NATIONAL PARK, VIRGINIA, IN RESPONSE TO ATMOSPHERIC DEPOSITION OF SULFUR.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
P. F. Ryan, G. M. Hornberger, B. J. Cosby, J. N. Galloway, and J. R. Webb.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2091-2099, October 1989. 5 fig, 2 tab, 28 ref.

Descriptors: *Sulfates, *Water chemistry, *Virginia, *Acid rain, *Sulfur, *Soil chemistry, Shenandoah National Park, Adsorption, Acid deposition, Alkalinity, Model studies.

Rates of atmospheric deposition of sulfur are as high in areas of the southeastern United States as they are in the northeastern United States and southeastern Canada. Sulfate concentrations and acidity of surface waters in the southeastern United States; however, remain low because of sulfate adsorption by soils. Because the capacity of soils to adsorb sulfate is finite, the questions of when and how fast the surface waters in the southeast might respond to the high rates of acidic deposition are of some importance. Modeling studies have suggested that time constants for sulfate breakthrough may be of the order of decades. Given that acidic deposition levels have been high in the southeastern United States since the 1940's, it might be expected that trends of increasing sulfate concentration and acidity would be apparent in data from monitored catchments. An analysis of 8 years of discharge chemistry data for two catchments in Shenandoah National Park, Virginia, indicates that sulfate concentrations and acidity are increasing in these catchments. The discharge-weighted mean annual sulfate concentrations increased at a rate of 2 microeq/L/yr for both streams over the 8 years of the study. Both catchments currently retain approximately 65% of deposited sulfate. The ratios of the rate of decrease of alkalinity to the rate of increase of sulfate concentration are 34% and 25% for the two streams. If deposition rates remain constant, the observed rates of increase indicate that steady state conditions will be approached in 100 years, at which time the stream alkalinities may be as low as minus 65 microeq/L. (Author's abstract)
W90-02187

NUMERICAL ANALYSIS OF SOLUTE TRANSPORT DURING TRANSIENT IRRIGATION: 1. THE EFFECT OF HYSTERESIS AND PROFILE HETEROGENEITY.
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
D. Russo, W. A. Jury, and G. L. Butters.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2109-2118, October 1989. 30 fig, 2 tab, 38 ref.

Descriptors: *Soil water, *Path of pollutants, *Water pollution sources, *Vadose water, *Solute transport, *Soil water, Hysteresis, Model studies, Interstitial water, Velocity, Profile heterogeneity, Soil properties.

Most of the existing data on vadose zone field scale solute transport have been obtained from experiments conducted under transient, nonmonotonic water flow. However, the majority of the theoretical analysis of these experiments have used models which assume monotonic steady state water flow

and uniform water content for the entire profile. In this study, transport of nonreactive solutes under nonmonotonic, transient water flow is analyzed numerically. The effect of hysteresis on solute transport is evaluated by making the soil hydraulic properties hysteretic using the procedure of Kool and Parker. The effect of profile heterogeneity on solute transport is analyzed by assuming that the medium is scale heterogeneous in a vertical direction, with a random scale factor. Results of the simulations show that under transient water flow, analysis of solute transport data with a steady state water flow model may considerably overestimate the effective vertical pore water velocity. Under nonmonotonic water flow, when the hysteretic characteristics of the soil are important, transient flow models which neglect hysteresis can also seriously overestimate the solute velocity. In addition, failure to account for profile heterogeneity will also overestimate the solute velocity, because both hysteresis and profile heterogeneity change the water content profile and concurrently retard solute transport relative to the movement predicted if the soil water system is considered as homogeneous and nonhysteretic. Analysis of the computed breakthrough curves suggest that direct estimates of the amount of water drained below a given depth may improve the goodness of fit of the solution of the convection dispersion equation with constant effective parameters to the breakthrough curves obtained under transient conditions. The fitted parameters, however, are depth dependent and the resulting effective solute velocity is smaller than the steady state pore water velocity. (Author's abstract)
W90-02189

NUMERICAL ANALYSIS OF SOLUTE TRANSPORT DURING TRANSIENT IRRIGATION: 2. THE EFFECT OF IMMOBILE WATER.
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
D. Russo, W. A. Jury, and G. L. Butters.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2119-2127, October 1989. 32 fig, 22 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Solute transport, *Soil water, Model studies, Irrigation, Evaporation, Distribution, Mobile-immobile water content, Transient flow.

The two-component mobile-immobile water model has been modified to describe solute transport under transient water flow induced by periodic cycles of irrigation, evaporation, and redistribution. To characterize transient flow, the soil water content is divided into a time-invariant immobile water content (Theta sub i) and a time-dependent mobile water content (Theta sub m) which obeys the Richards equation. Solute transport is described by the two-component mobile-immobile water model, modified to take into account the time dependence of the mobile water content. Results of the calculations show important differences between the behavior of the flux and residence concentrations under steady state water flow, particularly when the mass transfer coefficient alpha is relatively small. In this case, both resident and flux concentrations show a dispersion scale effect in their rate of spreading about the center of mass position in the soil. There were significant differences in solute transport predicted by the transient two-component model compared to the steady state model. The apparent velocity derived from the time variations of the position of the center of mass of the resident concentration decreased with time in the transient model, but was relatively constant in the steady state one. Apparently dispersion about the center of mass increased with time in both models, but was much higher in the transient model, caused principally by a build up of solute at the surface during evaporation cycles. (Author's abstract)
W90-02190

SOURCES OF ACIDIC STORM FLOW IN AN APPALACHIAN HEADWATER STREAM.
Pennsylvania State Univ., University Park. Program in Ecology.
B. R. Swistock, D. R. DeWalle, and W. E. Sharpe.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2139-2147, October 1989. 6 fig, 3 tab, 31 ref.

Descriptors: *Acid rain effects, *Acidic water, *Soil water, *Groundwater runoff, *Pennsylvania, *Storm water, *Aluminum, Hydrogen ion concentration, Sulfates, Conductivity, Organic carbon, Tracers, Acid streams.

A study was conducted to quantify the source of increased dissolved aluminum concentrations during acidic storm flows on a small Pennsylvania stream. Data for six episodes during fall 1986 and spring 1987 showed depressions in stream pH and increases in sulfates, conductivity, dissolved organic carbon, and dissolved aluminum. Flow separation analyses were conducted using O18 as a tracer in a three-component mass balance tracer model. Results showed that soil water and groundwater are the dominant flow sources, accounting for approximately 20 and 75% of total flow during storms, respectively. Channel precipitation generally provided less than 5% of total flows. Hydrograph separation using aluminum agreed with O18 results while other chemical parameters produced unsatisfactory results. The data support the results of previous variable source area concepts of storm flow generation with inputs of older, deep circulating groundwater from low-elevation source areas early in an event and later inputs of younger soil water and possibly shallow groundwater from expanding source areas at higher elevation. The results suggest that the most toxic runoff events for aquatic life occur during large storms when the greatest inputs of soil water cause elevated stream dissolved aluminum concentrations. Reductions in storm flow acidity and dissolved aluminum concentrations on this catchment will be most dependent upon changes in soil water and/or groundwater chemistry. (Author's abstract)
W90-02192

DENSITY-DRIVEN FLOW OF GAS IN THE UNSATURATED ZONE DUE TO THE EVAPORATION OF VOLATILE ORGANIC COMPOUNDS.
California Univ., Berkeley. Earth Sciences Div.
R. W. Falta, I. Javandel, K. Pruess, and P. A. Witherspoon.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2159-2169, October 1989. 12 fig, 7 tab, 37 ref.

Descriptors: *Path of pollutants, *Groundwater pollution, *Organic compounds, *Soil contamination, Advective gas flow, Numerical simulations, Volatile liquids, Evaporation.

A theoretical investigation of factors affecting the gas phase transport of evaporating organic liquids in the unsaturated zone is presented. Estimates of density-driven advective gas flow using a simple analytic expression indicate that significant advective gas flow will result from the evaporation of volatile liquids in soils having a high permeability. Numerical simulations using a two-dimensional cylindrical geometry and including the effects of phase partitioning between the solid, gas, water, and organic liquid phases show that mass transfer due to density-driven flow may dominate the gas phase transport of some organic chemical vapors in the unsaturated zone. Some common contaminants which are likely to be affected by density-driven flow include trichloroethylene, chloroform, 1,1,1-trichloroethane, methylene chloride, 1,2-di..ıloroethylene, 1,2-dichloroethane, 1-1-dichloroethane, carbon tetrachloride, Freon 113, and possibly, benzene. Some common contaminants which are not likely to be affected by density-driven flow include toluene, ethylbenzene, xylenes, chlorobenzene, naphthalene, and phenols. The general direction of density-driven flow is downward from the evaporating source toward the water table, and radially outward along the water table. (Author's abstract)
W90-02194

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 1. DERIVATION OF A DYNAMIC MODEL.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
G. A. Thomas.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2171-2176, October 1989. 3 fig, 1 tab, 22 ref.

Descriptors: *Surface-groundwater relations, *Path of pollutants, *Solute transport, *Groundwater pollution, *Stream pollution, *Model studies, Conservative solutes, Salinity, Aquifers, Piezometers.

A dynamic model is derived for the transport of a conservative solute along a stream connected to an aquifer contaminated by the solute. It relates downstream concentration to upstream concentration, stream discharge, and piezometric levels in the aquifer. Submodels for solute travel time in the stream and aquifer inflow into the stream are presented. In the presence of scarce data the model achieves two objectives: (1) to provide a daily estimate of stream salinity at a fixed downstream location during periods of low to medium flows in response to upstream flows and upstream salt concentration as well as to lateral inflows from salty aquifers; and (2) to quantify the salt load discharged from the aquifer into the stream in response to streamflow levels. (Author's abstract)
W90-02195

SOLUTE TRANSPORT IN A STREAM-AQUIFER SYSTEM: 2. APPLICATION OF MODEL IDENTIFICATION TO THE RIVER MURRAY.
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
A. J. Jakeman, C. R. Dietrich, and G. A. Thomas.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2177-2185, October 1989. 9 fig, 5 tab, 21 ref.

Descriptors: *Surface-groundwater relations, *Path of pollutants, *Solute transport, *Groundwater pollution, *Stream pollution, *Model studies, Aquifers, Salinity, Piezometers.

Using a model derived previously for the transport of a conservative solute along a stream connected to an aquifer, the model is applied to a 207-km reach of the River Murray in Australia. The appropriate model structure and its parameter values are determined using principals of system identification. The major tools applied are instrumental variable estimation techniques. The system identification procedure allows a testing of prior assumptions in the derivation of the accession model, determination of the appropriate dynamic model orders, and estimation of associated parameters. The success of the procedure adds support that the processes and assumptions largely apply, and it confirms that the interaction between aquifer and stream is basically linear and dynamic on a daily time scale. It shows that the response of a saline accession to a unit pulse change in the difference of aquifer and river level per unit river discharge is essentially a single exponential decay. The identification statistics prove that adding exponential terms to the series does not lead to increases of more than 1% in the ability to explain saline accession. The parameter estimation also quantifies the steady state salt load per unit stage height as equal to 292 tons/d. Furthermore, the saline accession response to a pulse is such that it takes approximately 4.3 days to decay to 1/3 of the peak of the pulse. (Author's abstract)
W90-02196

CONSISTENT SET OF PARAMETRIC MODELS FOR THE TWO-PHASE FLOW OF IMMISCIBLE FLUIDS IN THE SUBSURFACE.
California Univ., Davis. Dept. of Land, Air and Water Resources.
L. Luckner, M. T. van Genuchten, and D. R. Nielsen.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2187-2193, October 1989. 5 fig, 27 ref.

Descriptors: *Path of pollutants, *Unsaturated flow, *Multiphase flow, *Solute transport, *Groundwater pollution, *Hysteresis, *Model

studies, Hydraulic conductivity, Multiphase flow, Isotherms, Oil spills, Fluid retention.

Accurate estimates of the unsaturated hydraulic properties are needed for any quantitative description of multiphase flow in porous media. A consistent set of parametric models for this isothermal, hysteretic unsaturated fluid phase content (retention) and hydraulic conductivity functions of typical two-phase systems like water and air, or water and hydrocarbons is presented. The equations are obtained by combining expressions for the hysteretic fluid retention curves with the statistical pore size distribution model of Mualem which predicts the hydraulic conductivity from more easily measured fluid retention data. Hysteresis is described using the model of Scott et al. The functions were modified to allow inclusion of both wetting and nonwetting residual fluid saturations. The use of residual saturations is shown to be appropriate when a fluid phase becomes incoherently distributed, in which case the fluid does not move anymore as a connected (or linked) phase as described by Darcy's law in response to imposed pressure gradients. The existence of residual fluid saturations for both the wetting and nonwettng fluids is justified. Theoretical and experimental considerations indicate a need to match predicted and observed hydraulic conductivities at fluid phase contents less than full saturation. (Author's abstract)
W90-02197

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ELBE RIVER SUSPENDED PARTICULATE MATTER SEPARATED ACCORDING TO THE SETTLING VELOCITIES.
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik.
R. Niedergesaess, B. Racky, and C. Schnier.
Journal of Radioanalytical and Nuclear Chemistry, Articles, Vol. 114, No. 1, p 57-68, 1987. 8 fig, 5 ref.

Descriptors: *Path of pollutants, *Sediment transport, *West Germany, *Suspended solids, *Sediment sorting, *Settling velocity, Elbe River, Atterberg cylinders, Filtration, Neutron activation analysis, Irradiation.

Suspended particulate matter (SPM) in Elbe river water near Hamburg has been separated into different fractions by pouring the samples into special sedimentation tubes called Atterberg cylinders. The fractions are obtained by decanting the water after different settling periods, and by filtrating the decanted part. The analysis is done by neutron activation (INAA) in the absolute mode, after irradiation periods of 5 min and 3 days. The settling velocities of the elements As, Ag, Fe, Zn, U, and Cr generally remained below the SPM-mass velocity at all locations. These elements are probably bound to the organic fraction in the SPM. The element masses in the tide water samples settled generally more slowly than the appropriate SPM-mass. Nearly all the listed elements belong to these slowly sinking fractions. This means that the main part of the SPM consisted of fast settling elements not determined by INAA, probably quartz grains. Exceptions are Na, Hf, and Zr which settle faster than SPM-mass. This fraction has not yet been identified. The majority of the elements from the limnic samples settle faster than the main part of the SPM, which contained 40% organic matter. These elements starting with Nd and ending with Zr probably belong to the anorganic fractions. (White-Reimer-PTT)
W90-02205

STEROID ALCOHOLS AND KETONES IN COASTAL WATERS OF THE WESTERN MEDITERRANEAN: SOURCES AND SEASONAL VARIABILITY.
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
For primary bibliographic entry see Field 2L.
W90-02213

PROCESSES CONTROLLING THE CONCENTRATIONS OF SO4(--), NO3(-), NH4(+), H(+), HCOO-T AND CH3COO-T IN PRECIPITATION ON BERMUDA.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W90-02218

NA(+)/CL(-) RATIOS IN RAIN ACROSS THE USA, 1982-1986.
Arkansas Univ., Fayetteville. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W90-02219

BIOCONCENTRATION AND EXCRETION OF DIAZINON, IBP, MALATHION AND FENITROTHION BY WILLOW SHINER.
Shiga Prefectural Inst. of Public Health and Environmental Science, Otsu (Japan).
T. Tsuda, S. Aoki, M. Kojima, and H. Harada.
Toxicology and Environmental Chemistry TXECBP, Vol. 24, No. 3, p 185-190, 1989. 1 fig, 2 tab, 8 ref.

Descriptors: *Pesticides, *Bioaccumulation, *Insecticides, *Fungicides, *Diazinon, *Malathion, *Fish, *Biodegradation, *Excretion, *Path of pollutants, Fenitrothion, Biological magnification, Biotransformation, IBP, Shiner.

The bioconcentration and excretion of diazinon, IBP (S-benzyl diisopropyl phosphorothiolate), malathion and fenitrothion were studied for the freshwater fish, willow shiner (Gnathopogon caerulescens). The concentrations of these pesticides in whole body of fish reached plateaus in 6-48 h exposure (IBP 6 h, fenitrothion and malathion 24 h, diazinon 48 h). The average values of bioconcentration factors in whole body of fish were 33.2 for IBP, 398.5 for fenitrothion, 34.4 for malathion and 247.9 for diazinon through the 168 h exposure period. The excretion rate constants from whole body of fish were 0.07/h diazinon, 0.07/h for fenitrothion and 0.49/h for malathion, assuming their processes to be first-order kinetics. For IBP, the rate constant was 0.0017 g/ng/h, assuming the process to be second-order kinetics. (Author's abstract)
W90-02224

IMPACT OF INDUSTRIAL AND MINE DRAINAGE WASTES ON THE HEAVY METAL DISTRIBUTION IN THE DRAINAGE BASIN AND ESTUARY OF THE SADO RIVER (PORTUGAL).
Bordeaux-1 Univ., Talence (France). Groupe d'Oceanographie Physicochimique.
P. Quevauviller, R. Lavigne, and L. Cortez.
Environmental Pollution ENPOEK, Vol. 59, No. 4, p 267-286, 1989. 5 fig, 5 tab, 30 ref.

Descriptors: *Mine wastes, *Path of pollutants, *Heavy metals, *Water pollution sources, *Portugal, Cadmium, Zinc, Copper, Mercury, Tin, Nickel, Titanium, Zirconium, Sado River Estuary, Estuaries.

This paper presents results from a survey of the heavy metal distribution in sediments in the drainage basin and estuary of the Sado River (Portugal). In the drainage basin, heavy metals originated mostly from pyrite outcrop erosion and mining activities (Cd, Zn, Cu and locally Hg, Pg), and also from crust erosion (Sn, Ni, Ti, Zr). These sources were not correlated with the particulate organic carbon and so the metals were thought to be in inorganic forms in this area. Anthropogenic heavy metal sources (urban and industrial) were found in the lower estuary (Sn, Cd, Hg, Zn, Pb, and Cu), along with high particulate organic carbon concentrations. In this zone, these metals were thought to be strongly adsorbed onto organic particles. Furthermore, organo-metallic species were likely to be present, as demonstrated in the case of Sn, since methyl-tin and butyl-tin species were detected in sediments from this area. This suggests the need for the detection of organo-metallic species to understand the heavy metal geochemical cycles. No long-term changes in metal concentrations were found in sediment cores, except in the middle estuary (Zn, Cu) due to the development of mining activities on an industrial scale in the 1860s. (Author's abstract)
W90-02239

LEACHING FROM SOLIDIFIED WASTE FORMS UNDER SATURATED AND UNSATURATED CONDITIONS.
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
For primary bibliographic entry see Field 5D.
W90-02244

ACCUMULATION AND DIAGENESIS OF CHLORINATED HYDROCARBONS IN LACUSTRINE SEDIMENTS.
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
S. J. Eisenrelch, P. D. Capel, J. A. Robbins, and R. Bourbonniere.
Environmental Science and Technology ESTHAG, Vol. 23, No. 9, p 1116-1126, September 1989. 9 fig, 3 tab, 83 ref. NOAA Grant DOC-NA81-RAH00005.

Descriptors: *Tracers, *Chlorinated hydrocarbons, *Path of pollutants, *Lake Ontario, *Radioisotopes, *Pollutants, *Lakes, *Canada, *Chlorinated hydrocarbons, Lead radioisotopes, Cesium radioisotopes.

Two sediment cores were taken from the Rochester Basin of eastern Lake Ontario and analyzed for the radionuclides Pb-210 and Cs-137 and several high molecular weight chlorinated hydrocarbons. The two sites are geographically proximate but differ in sedimentation rate, permitting sedimentation-dependent processes to be factored out. The Pb-210 chronology showed a mixed depth of 3-5 cm and an intrinsic time resolution of 11-14 years. Vertically integrated numbers of deposit-feeding oligochaete worms and burrowing organisms were insufficient to homogenize the sediment on the time scale of chlorinated hydrocarbon inputs, which were non-steady state. U.S. production and sales of polychlorinated biphenyls, DDT, Mirex, and hexachlorobenzene, as determinants of the shape of the input function, adequately predicted the overall shape and, in many cases, details in the sedimentary profile. Sediment focusing factors inferred from Cs-137 and Pb-210 inventories averaged 1.17 for core E-30 and 1.74 for core G-32. This permitted chlorinated hydrocarbons accumulation rates to be corrected for focusing. Apparent molecular diffusion coefficients modeled for many fo the chlorinated hydrocarbons were about 0.01-0.03 sq nm/sec. (Author's abstract)
W90-02246

POLLUTION OF QUARTERNARY COVER ON AQUAFERS (SIC) OF EOCENE CHALK IN RAMAT HOVAV INDUSTRIAL AREA IN ISRAEL.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Geology and Mineralogy.
For primary bibliographic entry see Field 5E.
W90-02258

SULFUR CYCLING IN A DUTCH MOORLAND POOL UNDER ELEVATED ATMOSPHERIC S-DEPOSITION.
Agricultural Univ., Wageningen (Netherlands). Dept. of Soil Science and Geology.
T. C. Feijtel, Y. Salingar, C. A. Hordijk, J. P. R. A. Sweerts, and N. Van Breemen.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 215-234, April 1989. 6 fig, 2 tab, 54 ref.

Descriptors: *Path of pollutants, *Acid rain, *Sulfur, *The Netherlands, Water pollution sources, Ponds, Tracers, Seasonal variation, Deposition, Model studies, Kinetics.

Atmospheric S deposition, sulfate reduction and the accumulation of reduced S components were investigated in sediments of a Dutch moorland pool. Laboratory 35SO4(-2) tracer experiments indicated that the variation in reduction rate with depth in the sediment could be described by an exponential fit, suggesting first order kinetics. Sulfate reduction rates calculated from a kinetic trans-

port model were highest in June and July (greater than 0.6 mmol/sq m/day), and decreased towards the beginning of the spring. Concentrations of total, organic and inorganic S decreased with depth, consistent with an increasing depositional flux of S over the last century. Increased atmospheric sulfate deposition rates and consumption in the upper sedimentary layers caused a continuous increase in subsurface S concentrations. Present day S-immobilization rates were estimated between 25 to 30 mmol S/sq m/year, in the order of the annual input of S from wet atmospheric deposition. Sulfate metabolism in anaerobic moorland pool sediments may be the most important mechanism of long-term S-accumulation. (Author's abstract)
W90-02259

PROTOCOL FOR DETERMINING LAKE ACIDIFICATION PATHWAYS.
Environmental and Social Systems Analysts Ltd., Vancouver (British Columbia).
D. R. Marmorek, D. P. Bernard, C. H. R. Wedeles, and G. Sutherland.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 235-257, April 1989. 5 fig, 8 tab, 41 ref.

Descriptors: *Path of pollutants, *Acidic water, *Lakes, *Surveys, Acid rain effects, Wetlands, Environmental Protection Agency, Algorithms, Path of pollutants, Sulfur, Anions.

The chemistry of 282 low pH (less than 6.0) lakes sampled in the U.S. Environmental Protection Administration Eastern Lake Survey was evaluated in an attempt to assess why these systems have low pH. Evaluations were made using a decision protocol for classifying lakes according to several hypothesized acidifying mechanisms: acidic deposition, presence of wetlands and organic soils, acid mine drainage, watershed S sources, salt driven acidification, and changes in land use. The algorithm evaluates lakes in three steps: (1) initial exclusion criteria exclude from consideration lakes with pH greater than 6.0 or subject to strong confounding influences (e.g., road salt); (2) a general classification discriminates between lakes according to anion dominance; and (3) a secondary classification of lakes within each anion dominant class determine the most likely acidification pathway, using preliminary quantitative criteria designed to discriminate among competing hypotheses. Results computed for sampled lakes were scaled-up to produce regional population estimates, using the statistical framework of the Eastern Lake Survey. Acidic deposition appears to be the most likely cause of low pH conditions in the about two-thirds of the non-excluded lakes in the Eastern Lake Survey low pH target population. Organic acidity arising from wetlands or land use changes appears to be primarily responsible for the low pH status of one-quarter of these lakes. Watershed S sources and acid mine drainage appear to be of negligible importance, though further information on dry deposition rates and/or watershed soils is required to confirm this. (Author's abstract)
W90-02260

SIMPLE DOSE-EFFECT MODEL OF LAKE ACIDITY IN QUEBEC (CANADA).
Quebec Ministere de l'Environnement, Sainte-Foy. Direction de la Qualite du Milieu Aquatique.
J. Dupont, and Y. Grimard.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 259-272, April 1989. 4 fig, 33 ref.

Descriptors: *Quebec, *Acidic water, *Lakes, *Acid rain, *Sulfur, *Acid rain, Calcium, Magnesium, Physical properties, Hydrogen ion concentration, Dose-effect model.

A simple dose-effect model expressing the relationships between lake acidity, weighted mean annual sulfate concentration in wet deposition, Ca, Mg and true color (as an index of organic anion concentration) is presented. The agreement between observed and estimated pH for more than 1000 lakes is high according to the Pearson coefficients of correlation (0.81 to 0.90) and the standard error of estimation (0.22 to 0.27 pH unit). Results obtained with this model show that an airborne sulfate target loading of 20 kg/ha/yr would be too high to adequately protect sensitive lake ecosystems. A target loading of 15 kg/ha/yr in wet deposition would be best suited for the protection of the greater portion of sensitive lakes. However, a target loading of 10 kg/ha/yr would be required to protect the most sensitive lake ecosystems. (Author's abstract)
W90-02261

DISSOLVED AND PARTICULATE TRACE METALS IN A WETLAND OF INTERNATIONAL IMPORTANCE: LAKE MIKRI PRESPA, GREECE.
Athens Univ. (Greece). Inst. of Inorganic and Analytical Chemistry.
M. J. Scoullos, and J. Hatzianestis.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 307-320, April 1989. 4 fig, 2 tab, 30 ref.

Descriptors: *Path of pollutants, *Water pollution sources, *Heavy metals, *Trace metals, *Greece, *Wetlands, Copper, Lead, Zinc, Cadmium, Aluminum, Iron, Manganese, Nickel, Chromium, Trace metals, Lakes, Distribution, Suspended solids, Dissolved solids.

In Lake Mikri Prespa, a wetland of northwestern Greece, the dissolved and particulate trace metal distributions and concentrations of Cu, Pb, Zn, Cd, Al, Fe, Mn, Ni and Cr were determined in surface and hypolimnetic waters, as well as in the inputs and the outflow. Trace metals were connected with two major populations of suspended particles, identified by using the recovery ratio for two different leaching reagents, namely 0.5 N HCl and 1:1 hot aqueous HNO3. The first group is land derived and enters the lake through runoff and plays a rather restricted role in its geochemistry. The second group, which is more important, includes authigenic carbonates, Fe and Mn hydroxides and oxides and organic rich particulates that are more abundant in the near surface waters. (Author's abstract)
W90-02262

CHANGES IN SOIL AND STREAM HYDROCHEMISTRY DURING PERIODS OF SPRING SNOWMELT AT A PRISTINE SITE IN MID-NORWAY.
Macaulay Land Use Research Inst., Aberdeen (Scotland).
R. C. Ferrier, J. S. Anderson, and J. D. Miller.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 321-337, April 1989. 8 fig, 3 tab, 28 ref.

Descriptors: *Acid rain, *Acid snowpacks, *Soil water, *Soil horizons, *Snowmelt, *Norway, Elution, Soil moisture retention, Thawing, Hydrochemistry.

A detailed study of hydrochemical changes during spring snowmelt was undertaken at a pristine site in mid-Norway. The composition of catchment outflow water reflects hydrological pathways through different soil horizons and the contribution of pre-event or long-residence time water. There was evidence of secondary snowpack elution and ionic enrichment of water collected below the organic horizons. The observed time lag in commencement of BC soil horizon flow indicated that during the initial stages of the melt, water did not penetrate the deeper mineral horizons, or that initially the soil was not at field capacity. Increased soil and surface thawing is proposed as an important mechanism affecting the routing and subsequent chemical alteration of soil water leachate. During spring snowmelt events at this site, the relative proportions of surface, near surface, and sub-surface flow altered output chemistry. Should anthropogenic inputs to this pristine site increase, then the most important period of the melt would occur in the initial stages when hydrological pathways are direct and limit the relative importance of soil and groundwater neutralization mechanisms. (Mertz-PTT)
W90-02263

MODELING CL CONCENTRATIONS IN CAYUGA LAKE, U.S.A.
Upstate Freshwater Inst., Inc., Syracuse, NY.
M. T. Auer, and N. A. Johnson.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 347-362, April 1989. 9 fig, 3 tab, 25 ref.

Descriptors: *Chlorides, *Mine drainage, *New York, *Water pollution sources, *Sodium chloride, Model studies, Lakes, Simulation analysis.

The annual average concentration of Cl in Cayuga Lake, NY, has decreased from a value of approximately 102 mg/L in 1970, when the discharge of NaCl fines from an adjoining rock salt mine was discontinued, to a concentration of approximately 46 mg/L in 1988. A complete-mixed model for Cl concentration accurately simulated this decrease in concentration, establishing that the decrease was the result of an abrupt reduction in loading. The time course of the decrease strongly supports the position that the high Cl concentrations that prevailed in the lake in the late 1960s were largely a result of the discharge from the mining facility, and not due to the input of enriched groundwater as previously hypothesized. The predicted steady-state Cl concentration associated with the complete flushing of the mining facility input, expected in about the year 2000, is approximately 32 mg/L. Further, the model analysis supports previous speculation that the major source of material loading to the lake, the Seneca River, short-circuits to the outlet; i.e., this tributary should not be included in material budget for the lake. (Author's abstract)
W90-02264

DETERMINATION OF NITROPHENOLS IN RAIN AND SNOW.
Fraunhofer-Inst. fuer Toxikologie und Aerosolforschung, Hanover (Germany, F.R.).
M. Alber, H. B. Bohm, J. Brodesser, J. Feltes, and K. Levsen.
Fresenius Zeitschrift fuer Analytische Chemie ZACFAU, Vol. 334, No. 6, p 540-545, July 1989. 9 fig, 3 tab, 20 ref.

Descriptors: *Nitrogen compounds, *Phenols, *Path of pollutants, *Precipitation, *Snow, Gas chromatography, Electron capture gas chromatography, Mass spectrometry, Negative ion chemical ionization, Nitrophenols.

Nitrophenols have been determined in rain collected in Hannover (Federal Republic of Germany) over a period of 9 months in 1988 and in snow collected in Northrhine-Westphalia in February and March 1988. The precipitation samples were analyzed by gas chromatography using an electron capture detector, a nitrogen sensitive detector and a chemiluminescence detector (thermal energy analyzer) and by combined gas chromatography/mass spectrometry using both electron impact and negative ion chemical ionization and in addition by high performance liquid chromatography using a photodiode array detector. 2-Nitrophenol, 4-nitrophenol, 3-methyl-4-nitrophenol, 2,6-dimethyl-4-nitrophenol, 2,4-dinitrophenol, 2,4-dinitro-6-methylphenol, 2,4-dinitro-6-sec-butyl-phenol, one additional methylnitrophenol and two additional dimethylnitrophenols have been identified, several other compounds have been identified tentatively. In most instances 4-nitrophenol is the predominant component observed in concentrations ranging from 0.5-17.1 microgram/L in rain and from less than 0.5-16.1 microgram/L in snow. (Author's abstract)
W90-02267

OIL POLLUTION FROM RIVERS (KRONISKA OLJEUTSLAPP FRAN FLODER).
Swedish Environmental Research Inst., Stockholm.
L. Kaj, and C. Lehtinen.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-753695/GAR. Price codes: A03 in paper copy, A01 in microfiche. IVL-B-837, November 1986. 39p, 7 fig, 9 tab, 24 ref. English summary.

Descriptors: *Hydrocarbons, *Sweden, *Oil pollution, Gas chromatography, Fluorometry.

Concentrations of petroleum hydrocarbons in ten Swedish rivers have been measured. Total emission of hydrocarbons to Swedish coastal waters is estimated at 2000-2900 ton/year (gas chromatography analysis) and 2500-3800 ton/year (fluorimetric analysis). (Author's abstract)
W90-02276

MODELLING OF LARGE-SCALE HEAT AND CONTAMINANT TRANSPORT IN GROUND WATER. DFG RESEARCH GROUP AT THE UNIVERSITIES OF HOHENHEIM, KARLSRUHE AND STUTTGART--REPORT OF ACTIVITIES 1986/87 (MODELLIERUNG DEES GROBRAUMIGEN WARME-UND SCHADSTOFFTRANSPORTS IM GRUNDWASSER. DFG FORSCHERGRUPPE AN DEN UNIVERSITAETEN HOHENHEIM, KARLSRUHE UND STUTTGART--TATIGKEITSBERICHT 1986/87).
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
H. Kobus.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-770243/GAR. Price codes: A11 in paper copy, A01 in microfiche. NP-8770243, 1987. 242p, 81 fig, 4 tab, 60 ref. English summary.

Descriptors: *Path of pollutants, *Groundwater, *Heat flow, *Solute transport, *Model studies, *Groundwater movement, *Groundwater pollution, Aquifers, Chlorinated hydrocarbons, Nitrates.

General approaches for calculating the transport of heat and of groundwater constituents in aquifers were investigated. These were tested on specific examples and employed in drawing up concepts for sanitation, management, and protection of aquifers. On the basis of the flow-mechanical, hydrological, physical, and chemical fundamentals of materials transport, a general conceptual model was developed. To be suitable for practical use, this model must be compatible with actual data. Within this framework, fully-developed models for the transport of heat, chlorinated hydrocarbons, and nitrates will be devised. The theoretical, numerical, and experimental investigations needed for this have from the beginning been based on natural observations of real events. (Author's abstract)
W90-02278

EFFECT OF THE HEAVY METALS LEAD, CADMIUM, AND MANGANESE ON THE FRESHWATER GREEN ALGAE CHLAMYDOMONAS REINHARDII DANGEARD AND CHLORELLA FUSCA SHIHIRA AND KRAUSS: COMPARATIVE INVESTIGATION OF THE ACCUMULATION, TOXICITY, AND ULTRACYTOCHEMICAL LOCALIZATION OF HEAVY METALS (DIE WIRKUNG DER SCHWERMETALLE BLET, CADMIUM UND MANGAN AUF DIE SUSSWASSERGRUENALGEN CHLAMYDOMONAS REINHARDII DANGEARD UND CHLORELLA FUSCA SHINIRA ET KRAUSS: VERGLEICHENDE UNTERSUCHUNGEN ZUR ANREICHERUNG, TOXIZITAET UND ULTRACYTOCHEMISCHEN LOKALISATION).
Hamburg Univ. (Germany, F.R.). Fachbereich Biologie.
For primary bibliographic entry see Field 5C.
W90-02279

EXPERIMENTAL AND THEORETICAL STUDIES ON MASS TRANSFER IN AN ARTIFICIAL RAIN (EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNGEN ZUM STOFFUEBERGANG AN EINEM KUENSTILCHEN REGEN).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
G. F. Miss, H. Neumann, P. Petersen, H. J. Deeg, and G. F. Schulthesis.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-82124/GAR. Price codes: E09 in paper copy, A01 in microfiche. Report no. GKSS-87/E/29, 1987. 64p, 20 fig, 19 ref. English summary.

Descriptors: *Acid rain, *Path of pollutants, *Simulated rainfall, *Laboratory equipment, *Chemistry of precipitation, Rainfall rate, Trace gases, Mass transfer coefficients, Model studies.

The decrease of trace gas concentration in a rain is an unsteady process. For this reason the diffusive washout coefficient, which had not as yet been measured properly, could be determined exactly only by laboratory experiments. The setup for the generation of artificial rain comprised a long upright standing glass vessel, a sprinkling tank fitted with cannulas, a sump vessel, a sump with a supply of protective gas, a sulfur dioxide recording instrument and an injection nozzle for the trace gas. The evaluation of the experiments which were carried out showed that, for a given drip diameter, the mass transfer coefficient of the artificial rain has a constant value which is independent of rain intensity. There was good agreement between the measured values, the empirical mass transfer relationships and a theoretical flow model. (Author's abstract)
W90-02282

WASHINGTON, D.C. EXPERIMENT.
Brookhaven National Lab., Upton, NY.
A. A. N. Petrinos, M. J. Leach, and F. S. Binkowski.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-009159. Price codes: A02 in paper copy, A01 in microfiche. Report No. BNL-41147, (1988). 8p, 6 fig, 7 ref.

Descriptors: *Water pollution sources, *Nitrates, *District of Columbia, *Acid rain, Path of pollutants, Rainfall, Rainstorms, Sulfates, Meteorology.

In the heavily urbanized northeastern United States, mesoscale deposition of urban and industrial emissions can seriously effect human health and create acid rain. Studies conducted around Philadelphia, PA, during the period 1982 to 1985 provided strong indications of an impact of the urban emissions on precipitation chemistry in the city's environs. A study similar to the Philadelphia experiment was conducted around Washington, D.C. during the period October 1986 to April 19877. Although the fundamental approach to the experimental design was similar to that of the Philadelphia studies, a considerable upgrade in experimental and logistical sophistication was undertaken. The most significant upgrade involved the use of aircraft for in-cloud and below-cloud measurements during the sampled storms in support of the ground network operations. The ground network was composed of 31 sampling sites within a 100-km radius of the center of the city of Washington. Four storms were sampled successfully during the experimental period. (1) October 25-26, 1986 (labelled 1026); (2) November 7-8, 1986 (1108); (3) November 20, 1986 (1121); and (4); March 27-28, 1987 (0328). Because analysis of the data is continuing, the following conclusions should be considered tentative: (1) evidence indicates the impact of the urban plume on the deposition of nitrate and sulfate for storm 1026; (2) some uncertainty remains concerning storm 1108. However, it appears that the urban plume impacted the site in the southeastern vicinity of the corridor during the later stages of the rainfall; (3) storms 1121 and 1108 both showed significantly higher values at the sites to the immediate southeast of the urban corridor. The results implicate transportation emissions in the deposition of excess nitrate. This is based on the absence of significant industrial activity in the Washington, D.C. area. Mesoscale circulations can promote sharp variations in the air masses across the Washington-Baltimore corridor. These variations may include vertical gradients in oxidant concentrations and seriously affect ground-level acid deposition. (Lantz-PTT)
W90-02293

NORTH CAROLINA SANITARY LANDFILLS: LEACHATE GENERATION, MANAGEMENT AND WATER QUALITY IMPACTS.
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
R. C. Borden, and T. M. Yanoschak.
University of North Carolina Water Resources Research Institute Report No. 243, March 1989. 53p, 4 fig, 10 tab, 50 ref, append. Project 70087.

Descriptors: *Sanitary landfills, *Leachates, *Water pollution sources, *Waste disposal, *Monitoring, Water quality, Landfills, Solid wastes, Organic compounds, Groundwater pollution, Chemical analysis.

The most widely used method of solid waste disposal in North Carolina is burial in unlined municipally operated sanitary landfills (SLF's). Sanitary landfills generate leachate, a complex mixture of organic and inorganic pollutants. A statistical analysis of existing surface and groundwater monitoring data from 71 municipal sanitary landfills was performed to assess the impact of N.C. SLF's on surface and groundwater quality. A total of 322 surface and 411 groundwater quality records were analyzed using a computerized data analysis system. Almost all the landfill records included inorganic and heavy metal analyses while approximately half of the records also include organic scans by gas chromatography/mass spectrometry. Violations of groundwater quality standards for organic and/or inorganic pollutants were detected at 53% of the landfill sites examined for which adequate monitoring data exists. The severity of groundwater contamination at SLF's appears to be highly variable. At many of the landfills with groundwater quality problems, a 50% reduction in pollutant concentration would eliminate all violations. At a few isolated landfills, extremely high concentrations of organic and inorganic pollutants have been detected. At these landfills, pollutant concentrations may exceed the existing water quality standards by a factor of 10,000 or more. These results suggest that: (1) most landfills do contaminat groundwater; (2) the severity of contamination is highly variable; and (3) the existing monitoring program is reasonably effective at detecting widespread trends. The existing monitoring program is not adequate to detect ground or surface water contamination from individual landfills reliably. (Lantz-PTT)
W90-02310

FORMATION OF HALOGENATED ORGANICS DURING WASTEWATER DISINFECTION.
North Carolina Univ., Chapel Hill. School of Public Health.
For primary bibliographic entry see Field 5D.
W90-02315

FIELD EXPERIENCE WITH DISPERSANTS FOR OIL SPILLS ON LAND.
Petro-Green, Inc., Dallas, TX.
For primary bibliographic entry see Field 5G.
W90-02340

BEHAVIOR OF DISPERSED AND NONDISPERSED FUELS IN A SEWER SYSTEM.
Environment Canada, Ottawa (Ontario). Environmental Emergencies Technology Div.
M. F. Fingas, K. A. Hughes, and A. M. Bobra.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 274-289, 11 fig, 2 tab, 15 ref, append.

Descriptors: *Oil dispersants, *Fuel, *Dispersants, *Path of pollutants, *Sewers, Vaporization, Hydrocarbons, Fate of pollutants, Volatilization, Explosions.

A small-scale model sewer was constructed to determine the behavior of dispersed and non-dispersed fuel flushed or spilled into sewers. The system included a headbox containing a concrete pad with a drain in the middle. The drain fed into a sewer pipe. Six vapor sensors were positioned in ports or simulated manholes at intervals along the pipe length. The vapor sensors were connected to a computer which generated a continuous data record of vapor concentrations at each port. Liquid samples were also taken at different intervals under the vapor sensor ports. Vapors in a sewer system have two distinct origins: the first is vapor evaporating from the liquid fuel as it is transported with the water and the remainder is vapor that formed upstream and is in the process of moving downstream at a slower rate than the

underlying liquid. The latter movement is caused by the pumping action of the water flow, but is slower than the liquid flow as a result of the drag of the walls and the low gas-to-liquid friction coefficient. Gasoline, whether treated with dispersant or not, produces two sharply different vapor peaks at the sensor ports because it evaporates rapidly upon entering the sewer and thus produces a slowly moving vapor cloud. Diesel fuel does not evaporate as rapidly and produces only a single vapor peak at the ports. The use of dispersants at the beginning of the sewer increases the volatilization rate of the smaller fuel molecules and thus increases the amount of vapor present in the sewer system. This occurs irrespective of the amount or brand of dispersant employed. When dispersants are applied, the vapor concentration and duration is increased at each subsequent port. An increasing amount of dispersant or dispersant/water mixture increases this effect. If dispersants are mixed with the fuel in a very vigorous manner the vapor concentration may not be increased in the first ports, but it will not be decreased and the concentrations are increased 5 minutes downstream. In no case is the vapor concentration at any port reduced by the use of dispersants. The results from the small-scale model show that dispersants do not reduce the explosion risk of fuels in sewers. (See also W90-02334) (Author's abstract)
W90-02357

DENSITY MODELS.
Bechtel Civil, Inc., San Francisco, CA.
For primary bibliographic entry see Field 8B.
W90-02363

TRACING AND SUPERVISION OF POLLUTANT SOURCES.
For primary bibliographic entry see Field 5D.
W90-02420

EXPERT SYSTEM FOR MIXING ZONE ANALYSIS OF AQUEOUS DISCHARGES (CORMIX1): FURTHER DEVELOPMENTS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
G. H. Jirka, and R. L. Doneker.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-115687. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-88/205, October 1988. 7p, 8 fig, 3 ref. EPA Contract CR813093.

Descriptors: *Path of pollutants, *Fate of pollutants, *Computer models, *Mixing, *Model studies, Water pollution sources, CORMIX1, Flow profiles.

Two recent publications have reported the development of the Cornell Mixing Zone Expert System (CORMIX) for the analysis, prediction and design of aqueous toxic or conventional pollutant discharges into water sources, with emphasis on the geometry and dilution characteristics of the initial mixing zone. Subsystem CORMIX1 deals with submerged single port discharges into flowing water environments, such as rivers, estuaries, and coastal waters, and also includes the limiting case of stagnant waterbodies, such as lakes or reservoirs. The minimal hardware configuration for CORMIX1 is at the level of an IBM-PC/XT with printer for hardcopy output. CORMIX1 is applied to two, contrasting applications: (1) a reasonably simple discharge configuration--a vertical buoyant jet in uniform crossflow and unlimited (deep) water; and (2) a more complex pattern--the San Orofre thermal powerplant discharge in shallow coastal water. From the first example, it is concluded that for simple flow configurations--mostly well defined jets in the absence of any boundaries, such as bottom or water surface--CORMIX1 is as accurate as mathematically more complex models, such as those based on jet integral formulations with the entrainment hypothesis. In example 2, CORMIX1 predicts local instabilities and recirculation zones extending over the entire water depth, subsequent buoyant spreading along the water surface and upstream intrusion against the ambient current. The entire extent of the plume pattern at the water surface with its curved front is shown in plan view together with field data. This example (and others of this type) indicates that the knowledge base of CORMIX1 recognizes these flow complexities and provides reliable mixing zone predictions. (See also W90-02412) (Lantz-PTT)
W90-02428

COMPOSITION AND FATE OF PETROLEUM AND SPILL-TREATING AGENTS IN THE MARINE ENVIRONMENT.
Battelle Ocean Sciences, Duxbury, MA.
For primary bibliographic entry see Field 5C.
W90-02430

HYDROGEOLOGY OF MOUNTAIN KARST.
Akademiya Nauk Gruzinskoi SSR, Tiflis. Sector of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 2F.
W90-02446

ENVIRONMENTAL PROBLEMS AND INVESTIGATIONS IN THE KARST AREAS OF AUSTRIA.
Naturhistorisches Museum, Vienna (Austria). Karstological and Speleological Dept.
For primary bibliographic entry see Field 2F.
W90-02462

PROTECTION OF HIGHLY PERMEABLE AQUIFERS AGAINST CONTAMINATION BY XENOBIOTICS.
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
For primary bibliographic entry see Field 5G.
W90-02465

SOME CHARACTERISTICS OF SILT OF SUBTERRANEAN SYSTEM OF DJULA-MEDVEDICA IN OGULIN YUGOSLAVIA.
Forest Research Inst., Zagreb (Yugoslavia). Dept. of Typology.
B. Vrbek.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 299-304. 2 fig, 1 tab, 10 ref.

Descriptors: *Water pollution sources, *Caves, *Yugoslavia, *Groundwater pollution, *Karst hydrology, Chemical composition, Silt, Soil analysis, Heavy metals.

The Medvedica cave and Djula's precipice are presently connected into one subterranean system with a total channel length of 15701 m. Approximately 30 years ago, the natural flow of the river Dobra was diverted. As a result of this diversion, the river has become polluted with liquid wastes, sewage, and other materials; and the precipice no longer functions as it did originally. The growing refuse accumulation prevents water from sinking into the subterranean passages of the chalk formation into the precipice during periods of abundant rainfall, so it often flows out into the streets of Ogulin. Chemical investigations of silt from the Djula-Medvedica cave system measured standard soil chemistry (ph, CaCO3, P2O5, K2O, humus, total N, and mechanical soil composition), and the heavy metals, Fe, Mn, Zn, Cu, and Pb. Localities where samples were taken at random showed that not all parts of the subterranean system were evenly contaminated. The greatest changes exhibited were from samples taken from the center of Ogulin. Direct pollutants could not be determined by the current sampling method, and further analyses need to be done. (See also W90-02444) (Mertz-PTT)
W90-02476

5C. Effects Of Pollution

DEVELOPMENTAL TOXICITY OF DICHLOROACETONITRILE: A BY-PRODUCT OF DRINKING WATER DISINFECTION.
Health Effects Research Lab., Cincinnati, OH.
M. K. Smith, J. L. Randall, J. A. Stober, and E. J. Read.
Fundamental and Applied Toxicology FAATDF, Vol. 12, No. 4, p 765-772, May 1989. 6 tab, 20 ref.

Descriptors: *Chlorination, *Disinfection, *Water pollution sources, *Toxicity, *Water treatment, *Teratogenic effect, *Dichloroacetonitrile, Rats.

Dichloroacetonitrile (DCAN), a by-product of drinking water disinfection formed by reaction of chlorine with background organic materials, was evaluated for its developmental effects in pregnant Long-Evans rats. Animals were dosed by oral intubation on Gestation Days 6-18 (plug = 0) with 0, 5, 15, 25, or 45 mg/kg/day. Tricaprylin was used as a vehicle. The highest dose tested (45 mg/kg) was lethal in 9% of the dams and caused resorption of the entire litter in 60% of the survivors. Embryolethality averaged 6% per litter at the low dose and 80% at the high dose and was statistically significant at 25 and 45 mg/kg/day. The incidence of soft tissue malformations was dose related and was statistically significant at doses toxic to the dam (45 mg/kg). These abnormalities were principally in the cardiovascular (interventricular septal defect, levocardia, and abnormalities of the major vessels) and urogenital (hydronephrosis, rudimentary bladder and kidney, fused ureters, pelvic hernia, cryptorchidism) systems. The frequency of skeletal malformations (fused and cervical ribs) was also dose related and significantly increased at 45 mg/kg. The no-observed-adverse-effect dose for toxicity in pregnant Long-Evans rats was established to be 15 mg/kg/day. (Author's abstract)
W90-01948

TERATOLOGY OF 2,3,7,8-TETRACHLORODIBENSO-P-DIOXIN IN A COMPLEX ENVIRONMENTAL MIXTURE FROM THE LOVE CANAL.
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
J. B. Silkworth, D. S. Cutler, L. Antrim, D. Houston, and C. Tumasonis.
Fundamental and Applied Toxicology FAATDF, Vol. 13, No. 1, p 1-15, July, 1989. 1 fig, 6 tab, 29 ref.

Descriptors: *New York, *Hazardous wastes, *Teratogenic effect, *Water pollution effects, *Dioxins, *Love Canal, Chemical dumpsite, Leachates.

The organic phase of a leachate (OPL) from the Love Canal dump site contains more than 100 organic compounds including 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). The teratogenic potential of OPL was determined in two inbred and one hybrid mouse strain which differ in their sensitivity to aromatic hydrocarbon (Ah) receptor-mediated toxicity. OPL was administered to pregnant C57BL/6J mice (Ahb/Ahb) and to DBA/2J (Ahd/Ahd) females, which were mated with either DBA/2J or C57BL/6J males. In C57BL/6J mice, which express a high-affinity Ah receptor that avidly binds TCDD the ED50s of OPL for cleft palate and hydronephrosis were 0.44 and 0.11 g OPL/kg/day. Maternal mortality was 5% at the highest dose. In DBA/2J fetuses, which express a low-affinity receptor, neither treatment-related cleft palate nor hydronephrosis was induced by dose levels that caused 36% maternal mortality. In hybrid D2B6F1 fetuses, the incidence of cleft palate reached only 8% at 2 g OPL/kg/day, but the ED50 for hydronephrosis was 0.76 g OPL/kg/day. TCDD was similarly administered to pregnant C57BL/6J mice and to DBA/2J mice. In C57BL/6J fetuses, the ED50s for cleft palate and hydronephrosis were 4.6 and 0.73 microg TCDD/kg/day. In DBA/2J fetuses the ED50s for cleft palate and hydronephrosis were 15.0 and 6.4 microg TCDD/kg/day. Both the OPL and TCDD caused maternal hepatomegaly and thymic atrophy in all strains, but increased only C57BL/6J fetal weights. OPL decreased the number of fetuses per C57BL/6J dam at the two highest doses but there were no other reproductive effects in any of the groups. It was concluded that the OPL is teratogenic and that hydronephrosis is a sensitive meas-

ure of TCDD toxicity in a complex organic mixture. (Author's abstract)
W90-01949

EPIDEMIOLOGIC INVESTIGATION OF BIRTH OUTCOMES IN RELATION TO DIBROMOCHLOROPROPANE CONTAMINATION IN DRINKING WATER IN FRESNO COUNTY, CALIFORNIA, USA.
ENSR Health Sciences, Alameda, CA.
M. D. Whorton, O. Wong, R. W. Morgan, and N. Gordon.
International Archives of Occupational and Environmental Health IAEHDW, Vol. 61, No. 6, p 403-407, June 1989. 4 tab, 16 ref.

Descriptors: *Water pollution effects, *Epidemiology, *Drinking water, Human pathology, Dibromochloropropane, California.

An investigation of the relationship between dibromochloropropane (DBCP) contamination in drinking water and birth outcomes between 1978 and 1982 in Fresno County, CA, is described. Census tracts in the county were categorized according to DBCP level in drinking water. A direct comparison between exposure categories was done by the use of the Mantel-Haenszel chi-square procedure to compute relative ratios or risks for low birth weight and birth defect, adjusting for age, race, percent Hispanic, and parity. No correlation between these birth outcomes and DBCP contamination was found. In addition, no difference in sex ratio in relation to DBCP contamination was found. (Author's abstract)
W90-01952

MICROBIOLOGICAL CONTAMINATION OF THE OCEAN, AND HUMAN HEALTH.
New Jersey State Dept. of Health, Trenton. Div. of Occupational and Environmental Health.
M. J. Coye, and M. Goldoft.
New Jersey Medicine, Vol. 86, No. 7, p 533-538, July 1989. 5 fig, 1 tab.

Descriptors: *Water pollution effects, *Public health, *New Jersey, *Beaches, *Swimming, Epidemiology, Bioindicators, Water quality.

The potential link between water contamination and illnesses among swimmers was investigated epidemiologically. The swimming areas included nine New Jersey ocean beaches and two New Jersey lake beaches. Swimming activity, health outcome, and water-quality monitoring were the study components. Overall, water quality was excellent as measured by the four indicator organisms (fecal coliforms, enterococci, bacteriophages, and Clostridium perfringens). From reports by 5378 households with 16,089 individuals, children had higher illness rates than adults, and swimmers had higher rates than non-swimmers. Eye, throat, and skin infections were higher for swimmers; however, the symptoms were not related to contaminated swimming water. Gastroenteritis among swimmers occurred at rates of 30.9/1000 for lakes and 20.8/1000 for ocean beaches, compared to rates among nonswimmers of 13.6/1000 at lakes, and 8.6/1000 at ocean beaches. When combined with the good microbiological water quality occurring during the study, these results are indicative of safe conditions for swimmers at New Jersey coastal beaches. (Bazar-PTT)
W90-01956

EFFECT OF ORGANIC POLLUTION ON LOCAL DISTRIBUTION OF NEREIS DIVERSICOLOR AND COROPHIUM VOLUTATOR.
Rijkswaterstaat, Haren (Netherlands). Tidal Waters Div.
P. Esselink, J. van Belkum, and K. Essink.
Netherlands Journal of Sea Research NJSRBA, Vol. 23, No. 3, p 323-332, June 1989. 11 fig, 2 tab, 36 ref.

Descriptors: *The Netherlands, *Polychaetes, *Mud flats, Water pollution effects, Predation, Birds, Distribution, Nereis, Corophium.

Distribution patterns of Nereis diversicolor and Corophium volutator in the SE-Dollard, a 92 sq km tidal flat area in the NE Netherlands are described. Body condition as well as the maximal size of juvenile worms correlated positively with elevation of the mudflat, probably as a result of a better food supply on the higher mudflats. No spatial variation in size was found for C. volutator. N. diversicolor disappeared from ca.1 sq km of the intertidal mudflats in the autumn of 1985 as a consequence of seasonal waste discharges, whereas C. volutator disappeared from an area of ca.4 sq km. Though the discharges decreased by almost 50% from 1982 to 1985, N. diversicolor disappeared from about the same area in the 2 years. N. diversicolor is the main prey species of the avocet Recurvirostra avosetta, large flocks of which stay in the Dollard during autumn migration. Though the avocets lost ca.30% of their potential feeding area in the Dollard in the 1970s because of the high waste discharges, against only 5 to 10% in 1982 and thereafter (at significant lower discharges), the numbers of the avocets did not respond to the discharge decreases. (Author's abstract)
W90-01965

EFFECT OF OIL WELL BRINE ON GERMINATION AND SEEDLING GROWTH OF SEVERAL CROPS.
Ohio State Univ., Wooster. Agricultural Technical Inst.
D. A. Munn, and R. Stewart.
Ohio Journal of Science OJSCA9, Vol. 89, No. 4, p 92-94, Sep 1989. 5 tab, 9 ref.

Descriptors: *Water pollution effects, *Brines, *Crop yield, Oil wells, Germination, Plant growth, Ohio.

Large quantities of oil and gas well brines are produced annually in Ohio. This paper presents chemical parameters measured for a Wayne County, Ohio, oil well brine and reports the effects of several incremental brine concentrations on the germination and seedling development of soft red winter wheat (Triticum aestivum), soybeans (Glycine max), tall fescue (Festuca arundinacea), garden peas (Pisum sativum), and oats (Avena sativa). Chemical tests of two brine samples collected at the same well site showed large quantities of total solids (83 and 96 g/L), very high electrical conductivity (124 and 145 dS/m), and the presence of several elements at levels reported in the literature to be capable of causing crop injury or toxicity (Cl(-) 55 and 57 g/L, Na(+) 14.8 and 15.8 g/L, B 11 and 9 mg/L). The dominant ions present were Na(+) and Cl(-). Germination studies indicated that increasing the volume percentage of brine reduced the germination of tall fescue and soybeans more than wheat or garden peas. Increasing the volume percentage of brine caused the greatest reduction in plumule/hypocotyl enlargement in the following order: tall fescue > peas > wheat. In a 21-day greenhouse study, soybean dry matter yields were reduced more than those of oats by increasing the levels of brine in the water used to water the plants without leaching. (Author's abstract)
W90-02002

SEX-SPECIFIC REACTION OF LIVER ULTRASTRUCTURE IN ZEBRA FISH (BRACHYDANIO RERIO) AFTER PROLONGED SUBLETHAL EXPOSURE TO 4-NITROPHENOL.
Heidelberg Univ. (Germany, F.R.). Dept. of Zoology 1.
T. Braunbeck, V. Storch, and R. Nagel.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 185-202, April 1989. 18 fig, 2 tab, 64 ref. Bundesministerium fuer Forschung und Technologie/Deutsche Forschungs Gemeinschaft Nagel 03-7324-8 and German Research Foundation (DFG Sto 75/9).

Descriptors: *Water pollution effects, *Sublethal effects, *Fish physiology, *Toxicity, *Phenols, Zebra fish, Brachydanio, Liver, Tissue analysis, Nitrophenols.

Morphological alterations of the liver of zebra fish (Brachydanio rerio) following prolonged exposure to 0.1, 1.0, and 5.0 mg/L 4-nitrophenol (4-NP) were investigated by means of light and electron microscopy. Based on a marked sexual dimorphism in control animals, liver reactions were both sex-dependent and dose-dependent. Whereas at 0.1 mg/L only minor changes could be revealed, there were numerous structural modifications at 1 mg/L. Whereas male fish primarily react with a proliferation of smooth endoplasmic reticulum, female fish display a high degree of fenestration within cisternae of the rough endoplasmic reticulum. Both sexes exhibit infiltration of macrophages and lymphocytes, an increase in the number of binucleate cells, of lysosomes, autophagosomes and myelinated bodies, but a depletion of hepatic glycogen. At 5 mg/L, deformations of the nuclear membrane and partial lysis of mitochondria could be observed. At 1 and 5 mg/L 4-NP about 25% of the animals investigated showed symptoms of degenerative transformations of the liver tissue into huge multinucleate cell masses with completely different ultrastructure. The evaluation of the results leads to the conclusion that for toxicological studies on the effects of 'priority pollutants' histological and cytological investigations should be incorporated into an integrated methodological scheme. (Author's abstract)
W90-02029

REGENERATION OF CONTAMINANT-INDUCED LIVER LESIONS IN FLOUNDER--EXPERIMENTAL STUDIES TOWARDS THE IDENTIFICATION OF CAUSE-EFFECT RELATIONSHIPS.
Biologische Anstalt Helgoland (Germany, F.R.)
A. Kohler.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 203-232, April 1989. 13 fig, 1 tab, 78 ref.

Descriptors: *Toxicity, *Fish physiology, *Flounders, Mercury, Benzenes, Polychlorinated biphenyls, Water pollution effects, Liver, Platichthys, Elbe River, West Germany, Detoxification, Biotransformation, Reversibility.

Regeneration experiments on the liver of flounder (Platichthys flesus L.) were performed in order to identify the role of diverse pollutants (Hg, PCBs, hexachlorobenzene, OCS, hexachlorocyclohexane-isomers) in the pathogenesis of the liver abnormalities observed during a 3-year multidisciplinary survey in the Elbe estuary, West Germany. Flounder kept under contaminant-free conditions and fed ad libitum with uncontaminated food indicated initial and complete liver regeneration in 50% of the individuals after 20 days, and in 70% after 40 days. Signs of regeneration, diagnosed at the light microscope and electron microscope level were accompanied by a significant decrease in the concentration of chlorinated hydrocarbons in the liver. Livers of flounder without regenerative signs maintained their high levels of contaminants. The ultrastructural findings indicated that transfer of Elbe flounder into a contaminant-free environment induced increased activity of biotransformation and detoxification in the hepatocytes (tubular SER, lysosomes). It was concluded that the metabolically resistant or slowly metabolized contaminants analyzed in the flounder population of the Elbe estuary apparently induced considerable hepatotoxic effects. The criterion of the reversibility of contaminant-induced pathological change seems to be a valuable tool for the assessment of environmental impacts of anthropogenic discharges. (Author's abstract)
W90-02030

INFLUENCE OF WATER QUALITY ON MACROINVERTEBRATE COMMUNITY RESPONSES TO COPPER IN OUTDOOR EXPERIMENTAL STREAMS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
W. H. Clements, J. L. Farris, D. S. Cherry, and J. Cairns.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 249-262, April 1989. 4 fig, 3 tab, 35 ref.

Descriptors: *Toxicity, *Water pollution effects, *Aquatic insects, *Artificial watercourses,

*Copper, *Monitoring, Midges, Caddisflies, Tolerance, Statistical analysis, Species composition.

Experiments were conducted in artificial streams to examine the influence of water quality on macroinvertebrate community responses to copper (Cu). Macroinvertebrate communities were established on substratum-filled trays placed in the Clinch River and transferred to two artificial stream systems (New River and Clinch River streams) receiving water from different sources. Alkalinity and hardness in Clinch River (CR) streams were ca 2-3 times greater than in New River (NR) streams. Results of ANCOVA indicated that effects of Cu were greater in NR than in CR streams. After 4 days, total macroinvertebrate abundance was reduced by 32% in NR streams at 6 microg Cu/L but only by 25% in CR streams at 15 microg/L. After 10 days, Tanytarsini chironomids, the dominant and most sensitive organisms collected, were eliminated from NR streams at 13 microg Cu/L but reduced by only 35% in CR streams at similar Cu levels. Results of canonical discriminant analysis also revealed greater impact of Cu in NR streams. After 10 day, macroinvertebrate communities in NR streams at 9 microg Cu/L were similar to those in CR streams at 24 microg/L. Responses to Cu in both experimental streams and at impacted field sites were highly variable among taxa. Orthocladiini chironomids and net-spinning caddisflies were quite tolerant of Cu in experimental streams and were the only groups that recovered in the field. The results demonstrate the importance of accounting for both water quality and composition of the resident fauna for establishing site-specific water quality criteria. (Author's abstract)
W90-02032

ALGAL INTERACTIONS WITH THE GENOTOXIC ACTIVITY OF SELECTED CHEMICALS AND COMPLEX LIQUID SAMPLES.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
M. Harwood, C. Blaise, and P. Couture.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 263-276, April 1989. 5 fig, 2 tab, 43 ref.

Descriptors: *Industrial wastewater, *Toxicity, *Water pollution effects, *Chlorophyta, Selenastrum, Light, Detoxification, Bioassay, Genotoxicity, Algal metabolism.

Ultra-acute 4 hr algal interaction experiments on the genotoxic activity of three chemicals: N-methyl-N1-nitro-n-nitroso-guanidine (MNNG), 4-nito quinoline N-oxide (4NQO), and 2-amino anthracene (2AA); and 9 complex liquid samples (4 organic chemical manufacturing effluents, 2 associated intake water supplies, 2 inorganic manufacturing effluents, and 1 pulp and paper effluent) were undertaken with Selenastrum capricornutum. Genotoxic activity was determined with the SOS Chromotest on each pre-exposure test solution and on each post-exposure supernatant and algal cell extract. Responses with the chemicals ranged from no activity change for MNNG to detoxification for 4NQO and to detoxification/uptake for 2AA. Exposure to experimental light and centrifugation were also shown to have a significant effect in reducing the activity of 2AA. All but one of the complex liquid samples proved to be genotoxic and exposure responses were varied. As well as effects noted for the chemicals, increased genotoxic potency was observed in 3 samples, suggesting the presence of pro-mutagens capable of being activated by algal metabolism. The results indicate that phytoplankton could play an important positive (detoxification) or negative (activation, uptake) role in its interactions with genotoxicants present in complex liquid wastes discharged to the aquatic environment. (Author's abstract)
W90-02033

QUANTITATIVE STRUCTURE--ACTIVITY RELATIONSHIPS FOR THE EFFECT OF HYDROPHOBIC ORGANIC CHEMICALS ON RATE OF FEEDING BY MUSSELS (MYTILUS EDULIS).
Marine Biological Association of the United Kingdom, Plymouth (England).
P. Donkin, J. Widdows, S. V. Evans, C. M. Worrall, and M. Carr.
Aquatic Toxicology AQTODG, Vol. 14, No. 3, p 277-294, April 1989. 2 fig, 2 tab, 59 ref.

Descriptors: *Structure-activity relationships, *Mytilus, *Feeding rates, *Toxicity, *Water pollution effects, Organic compounds, Bioassay, Feeding, Molecular weight, Octanol-water partition coefficient, Hydrophobic organic chemicals, Mytilus.

The effect of hydrophobic organic chemicals on the rate of feeding by mussels (Mytilus edulis) was investigated, and the effect expressed as the toxicant concentration in water required to reduce feeding rate by 50% (WEC50). A quantitative structure-activity relationship (QSAR) was derived in which WEC50 was negatively correlated with log10 octanol-water partition coefficient (log k sub ow) and positively correlated with aqueous solubility, indicating that hydrophobicity has a major influence on toxicity. QSARs calculated between bioconcentration factor, octanol-water partition coefficient and aqueous solubility showed, that hydrophobicity influences toxicity largely through its effect on bioconcentration. This observation was confirmed by expressing toxicity as the toxicant concentration in mussel tissue required to reduce feeding confirmed by expressing toxicity as the toxicant concentration in mussel tissue required to reduce feeding rate by 50% (TEC50). For the compounds tested which have the octanol-water partition coefficient values < 4.6, TEC50 was relatively constant, irrespective of molecular structure. Compounds with the octanol-water partition coefficient values > 5 could be accumulated to much greater concentrations before feeding rate was affected, indicating that there is a 'molecular weight cut-off' in the toxicological response. These observations are characteristic of a non-specific narcotic mode of toxic action. (Author's abstract)
W90-02034

MEASURING THE BIOLOGICAL EFFECTS OF POLLUTION: THE MUSSEL WATCH APPROACH.
Marine Biological Association of the United Kingdom, Plymouth (England).
For primary bibliographic entry see Field 5A.
W90-02051

UK STATE-OF-THE-ART: SEWERAGE REHABILITATION.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5D.
W90-02052

EVALUATION OF A SHORT-TERM CHRONIC EFFLUENT TOXICITY TEST USING SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS) LARVAE.
M. M. Hughes, M. A. Heber, G. E. Morrison, S. C. Schimmel, and W. J. Berry.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 1-14, 1989. 5 tab, 20 ref.

Descriptors: *Wastewater treatment, *Wastewater disposal, *Wastewater analysis, *Water analysis, *Toxicity, *Bioassay, *Killifish, *Quality control, Cyprinodon, Chronic toxicity, Industrial wastes, Sensitivity, Growth, Survival, NPDES permit regulations.

In response to recent changes in National Pollutant Discharge Elimination System (NPDES) permit regulations, rapid (7-day) static renewal toxicity tests have been developed to detect chronic (sublethal and lethal) effect concentrations of municipal and industrial effluents on freshwater and marine/estuarine organisms. Results from short-term (7-day) chronic effluent tests measuring effects on the growth and survival of the larvae of estuarine sheepshead minnow (Cyprinodon variegatus) have been evaluated. Growth was the more sensitive endpoint in 52% of the effluent tests; survival was most sensitive in 7% of the tests. Growth and survival were equally sensitive endpoints in 26% of the tests, while there was no effect on either endpoint at the highest test concentration in 15% of the tests. Four short-term chronic tests were conducted concurrently with early life stage (ELS) tests using a common effluent. Effect concentrations were generally (two to three) within one dilution (a factor of three). Comparisons of short-term chronic and ELS tests were also conducted with reference single chemicals and the results were slightly better than the effluent comparisons. A series of ten intralaboratory tests and seven interlaboratory tests were conducted to assess the variability among test results. Toxicity in these tests varied by no more than one test concentration interval. It was concluded that this sheepshead minnow test is suitable to estimate chronic values for complex effluents discharged to marine/estuarine environments within the NPDES permit regulations. (Author's abstract)
W90-02111

SURVIVAL, GROWTH AND REPRODUCTION OF DAPHNIA CARINATA (CRUSTACEA: CLADOCERA) EXPOSED TO CHRONIC CADMIUM STRESS AT DIFFERENT FOOD (CHLORELLA) LEVELS.
Delhi Univ. (India). Dept. of Zoology.
T. Chandini.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 29-45, 1989. 3 fig, 3 tab, 50 ref.

Descriptors: *Toxicity, *Bioassay, *Cadmium, *Daphnia, Survival, Growth, Reproduction, Chlorella, Food levels, Life history studies.

In nature, organisms have to respond to a diversity of factors acting simultaneously. The present investigation was conducted to study whether changes in food (Chlorella) levels could modify the chronic toxicity of cadmium on the various life-history parameters, such as survivorship, longevity, life expectancy, fecundity, age at first reproduction, net reproductive rate (R sub o), generation time (T), intrinsic rate of natural increase (r), and growth rates of the cladoceran Daphnia carinata. The study indicated that at low food levels (0.5 x 10 to the sixth power cells/ mL Chlorella), cadmium concentrations in the range of 27-162 microg/L reduced these life-history parameters by 50% (EC50). At medium food levels (1.5 x 10 to the sixth power cells/mL Chlorella) the EC50 of cadmium was in the range of 51-127 microg/L. At high food levels (4.5 x 10 to the sixth power cells/mL Chlorella), the toxic effect of cadmium was greatly reduced. The decreases in survival, growth and reproduction of D. carinata at high cadmium-low food levels affected the fitness parameter 'r'. The study emphasizes the need to include reproductive parameters other than mere survival in toxicity bioassays. The study also stresses the need to incorporate in laboratory tests other relevant factors that might modify pollutant toxicity. (Author's abstract)
W90-02112

TESTING OF COLORED SAMPLES FOR TOXICITY BY THE ALGAL-ATP BIOASSAY MICROPLATE TECHNIQUE.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 5A.
W90-02113

BIOLOGICAL WATER QUALITY ASSESSMENT OF RUNNING WATERS BASED ON MACROINVERTEBRATE COMMUNITIES: HISTORY AND PRESENT STATUS IN EUROPE.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 7A.
W90-02116

CHANGING ATMOSPHERE.
T. E. Graedel, and P. J. Crutzen.
Scientific American SCAMAC, Vol. 261, No. 3, p 58-68, 1989. 5 ref.

Descriptors: *Atmospheric chemistry, *Projections, *Air pollution effects, *Acid rain, *Ozone,

*Greenhouse effect, Corrosion, Sulfur compounds, Hydrocarbons, Nitrogen compounds, Methane, Carbon dioxide, Air pollution, Chlorofluorocarbons.

The composition of the earth's atmosphere has changed significantly faster in the past two centuries than it has at any time in human history. The effects of these changes include: acid rain, corrosion of materials, urban smog, the thinning of stratospheric ozone, and the heating of the earth called the greenhouse effect. These effects are caused in large part by increases in the levels of several of the atmosphere's minor constituents, or trace gases, including sulfur dioxide (SO2), two nitrogen oxides known collectively as NOx, and several chlorofluorocarbons. Changes in the earth's atmosphere can be attributed to many human activities such as the burning of vegetation, the combustion of fossil fuels, smelting and other industrial activities, and agricultural practices. Acid rain develops mainly as a by-product of atmospheric interactions involving the NOx gases and sulfur dioxide. Acids deposited as rain, snow, dew, or 'dry' gases and particles contribute to the corrosion of outdoor equipment, buildings, and works of art. The term urban smog refers to the mixture of emissions (particularly NOx gases and hydrocarbons) to produce reactive gases that can be destructive to living organisms. The severity of smog is generally assessed on the basis of ground-level ozone concentrations. The depletion of stratispheric ozone, on the other hand, which results in an increase in ultraviolet radiation reaching the earth, is attributed to chlorofluorocarbons. Frigid temperatures in Antarctica and the Arctic hasten the chlorine-catalytic cycles that disturb the natural balance in the stratisphere and result in a net ozone loss. Several different emissions contribute to the greenhouse warming of the earth, including carbon dioxide, methane, the chlorofluorocarbons, and nitrous oxide. Sharp increases in greenhouse gases in the past decades makes added heating inevitable. Projections for the future are discouraging and the solution to the earth's environmental problems lies in a truly global effort, involving unprecedented collaboration by scientists, citizens and world leaders. (Ence-PTT)
W90-02131

EFFECTS OF ACID FOG AND DETERGENTS ON FOLIAR LEACHING OF CATIONS.
Florence Univ. (Italy). Dipt. di Biologia Vegetale.
For primary bibliographic entry see Field 5B.
W90-02158

HEMAGGLUTINATION AND INTESTINAL ADHERENCE PROPERTIES OF CLINICAL AND ENVIRONMENTAL ISOLATES OF NON-01 VIBRIO CHOLERAE.
National Inst. of Cholera and Enteric Diseases, Calcutta (India). Dept. of Immunology.
K. Datta-Roy, C. Dasgupta, and A. C. Ghose.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2403-2406, September 1989. 2 fig, 2 tab, 28 ref.

Descriptors: *Water pollution effects, *Pathogenic bacteria, *Aquatic bacteria, *Vibrio, Intestinal adherence, Hemagglutination, Human diseases, Laboratory studies.

Hemagglutination and intestinal adherence properties of non-O1 Vibrio cholerae were studied in vitro. No definite correlation between the cell-associated hemagglutinin titers and the intestinal adhesion indices was noted. Sugar- and glycoprotein-mediated inhibition data also indicated differences between the hemagglutination and adherence processes in respect to the receptor structures. Intestinal adherence of most V. cholerae strains could be inhibited to various extents by N-acetyl D-glucosamine. This observation provides a likely explanation fr the ecological behavior of these organisms, which are known to associate themselves with chitinous (chitin:homopolymer of N-acetyl D-glucosamine) surfaces of zooplankton. The absence of any significant difference between the intestinal adherence indices of clinical and environmental isolates suggests that intestinal adhesion may be an essential but not sufficient prerequisite for colonization by and subsequent expression of pathogenicity of these microorganisms. (Author's abstract)
W90-02169

RELATION BETWEEN AEROMONAS AND FAECAL COLIFORMS IN FRESH WATERS.
Barcelona Univ. (Spain). Dept. of Microbiology.
R. M. Araujo, R. M. Arribas, F. Lucena, and R. Pares.
Journal of Applied Bacteriology JABAA4, Vol. 67, No. 2, p 213-217, August 1989. 1 fig, 3 tab, 20 ref.

Descriptors: *Water pollution effects, *Wastewater pollution, *Pathogenic bacteria, *Aeromonas, *Fecal coliforms, *Bioindicators, Organic matter, Biological oxygen demand.

A possible correlation between the presence of mesophilic aeromonads and the number of fecal coliforms present in three freshwater habitats subject to differing levels of fecal pollution was investigated. Concentrations of Aeromonas spp. between 100 and 10 to the 9th power cfu/100 ml and fecal coliforms of between 9 and 10 to the 7th power cfu/100 ml were found in the waters. In water free from fecal pollution there was no correlation but in polluted waters there was a significant relationship between the numbers of aeromonads, fecal coliforms and the concentration of organic matter measured by biological oxygen demand. (Author's abstract)
W90-02175

EFFECT OF CALCIUM CONCENTRATION ON THE TOXICITY OF COPPER, LEAD AND ZINC TO YOLK-SAC FRY OF BROWN TROUT, SALMO TRUTTA L., IN SOFT, ACID WATER.
Nottingham Univ. (England). Dept. of Zoology.
M. D. J. Sayer, J. P. Reader, and R. Morris.
Journal of Fish Biology JFIBA9, Vol. 35, No. 3, p 323-332, September 1989. 3 fig, 1 tab, 26 ref. Natural Environment Research Council grant GR3/6176.

Descriptors: *Acid rain effects, *Water pollution effects, *Toxicity, *Heavy metals, *Trout, *Acidic water, *Calcium, Fisheries, Copper, Lead, Zinc.

Yolk-sac fry of brown trout were exposed to three levels of single trace metals (Cu, 20, 40, 80 nmol/l; Pb, 12.5, 25, 50 nmol/l; Zn, 75, 150, 300 nmol/l) typical of concentrations reported for acid soft waters, in flowing, artificial, soft water media maintained at pH 4.5 and 20 or 200 micromol/l Ca for 30 days. Mortalities were high in fry subjected to all levels of the three trace metals at 20 micromol/l Ca, with 80% of the total deaths occurring between days 11 and 15 of the experiment. 25% mortality occurred at low Ca concentration and pH 4.5 in the absence of tracer metals, with only one death recorded at 200 micromol/l Ca (Cu, 80 nmol/l). At high Ca concentrations all three levels of Cu and Pb impaired net Na and K uptake; Cu was the only metal to reduce the uptake of Ca. The Zn treatments had no significant effect on mineral uptake. Calcification of centra was reduced by all three Cu treatments at 200 micromol/l Ca. The lowest Zn concentration (75 nmol/l) was the only other treatment to impair skeletal development. In the absence of trace metals, low Ca concentrations significantly reduced Ca, Na and K uptake, skeletal calcification and dry mass at pH 4.5. It is possible that membrane-bound Ca is removed from the gills more rapidly when both external Ca concentration and pH are low, increasing gill permeability and ion losses. Trace metal uptake may therefore be increased at low Ca concentrations due to increased gill permeability. (Sand-PTT)
W90-02177

TOXICITY VERSUS AVOIDANCE RESPONSE OF GOLDEN SHINER, NOTEMIGONUS CRYSOLEUCAS, TO FIVE METALS.
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental Studies.
For primary bibliographic entry see Field 5A.
W90-02178

MICROBIAL ADAPTATION TO DEGRADATION OF HYDROCARBONS IN POLLUTED AND UNPOLLUTED GROUNDWATER.
Copenhagen Univ. (Denmark). Dept. of General Microbiology.
For primary bibliographic entry see Field 5G.
W90-02180

EFFECT OF FUEL OIL ON THE ULTRASTRUCTURE OF THE CHLOROCOCCAL ALGA SCENEDESMUS ARMATUS.
Gdansk Univ. (Poland). Dept. of Plant Physiology.
Z. Tukaj.
Protoplasma PROTA5, Vol. 151, No. 1, p 47-56, 1989. 12 fig, 1 tab, 34 ref.

Descriptors: *Oil spills, *Scenedesmus, *Oil, *Toxicity, *Water pollution effects, Ultrastructure, Detoxification.

Characteristic changes in the ultrastructure of the green alga Scenedesmus armatus grown in batch culture in the presence of aqueous fuel-oil extract (AFOE) were observed. The changes affected mainly chloroplasts and mitochondria. The regular arrangement of the thylakoid stacks became distorted and the whole chloroplast lobed. Plastoglobules were more numerous in the treated cells than in the controls, especially after long-term exposure to AFOE. The mitochondria matrix cell exposed to AFOE were more electron-translucent. An increase in the number of small mitochondrial profiles was observed after prolonged treatment with AFOE. The number and size of osmophilic bodies increased markedly in the cytoplasm of the treated cells. The cytochemical reaction of these bodies with Sudan black B indicated their lipid composition. Plasmalemma invagination into the cytoplasm and vacuoles, cytoplasmic 'layers', and an increase in size of the vacuolar compartment were observed in cells exposed to AFOE for a long time. The possibility that detoxification, involving microbody activity, may have occurred in Scenedesmus is suggested. (Author's abstract)
W90-02217

ECOTOXICITY STUDIES OF SOME ORGANOTIN MONOMERS AND POLYMERS.
Indian Inst. of Tech., Bombay. Centre for Environmental Science and Engineering.
J. R. Dharia, B. M. Gavande, and S. K. Gupta.
Toxicology and Environmental Chemistry TXECBP, Vol. 24, No. 3, p 149-154, 1989. 3 tab, 7 ref.

Descriptors: *Antifoulants, *Tin, *Pesticides, *Organic compounds, *Organotins, *Toxicity, *Water pollution effects, Aquatic bacteria, Crustaceans, Pseudomonas, Sarcina, Brine shrimp.

Ecotoxicity data are reported for alpha-substituted tributyltin monomers and polymers against two species of bacteria, viz. Pseudomonas aeruginosa and Sarcina lutea, and a crustacean species, Artemia salina larva. The toxicity of the compounds increased with the increase in tributyltin contents in the polymers. The homopolymers were most toxic towards the larvae amongst the polymers. Uncured polymers were found to be more toxic than cured polymers. It was not possible to correlate the biotoxicity with the chemical structure of the polymer. (Author's abstract)
W90-02221

HYDROGRAPHIC AND PLANKTONIC VARIABILITY IN THE SARONIKOS GULF.
National Centre for Marine Research, Athens (Greece).
N. Friligos.
Toxicology and Environmental Chemistry TXECBP, Vol. 24, No. 3, p 155-170, 1989. 14 fig, 2 tab, 47 ref.

Descriptors: *Water pollution effects, *Coastal waters, *Phytoplankton, *Zooplankton, *Eutrophication, Chlorophyll a, Water temperature, Salinity, Nutrients, Nitrogen, Phosphorus, Silicon, Saronikos Gulf, Aegean Sea, Hydrography, Wastewater pollution.

Five stations in the Saronikos Gulf were studied during 1983-84, one located in Elefsis Bay, an industrial area, and the others located at a distance where the effects of effluents were minimized. A differential discharge of untreated urban wastes and industrial effluents adds to the distinctiveness of the two parts. Various physical, chemical, and biological (chlorophyll a, phytoplankton, zooplankton) factors were measured seasonally. Temporal and spatial distribution of surface temperature, salinity, nutrients (N, P, Si), chlorophyll a, and plankton were reported and the areas exposed to local eutrophication identified. Significant correlations between phytoplankton standing crop, chlorophyll a, zooplankton and various environmental parameters were demonstrated. (Author's abstract)
W90-02222

EUTROPHICATION AND RED TIDE IN AEGEAN COASTAL WATERS.
National Centre for Marine Research, Athens (Greece).
N. Friligos, and O. Gotsis-Skretas.
Toxicology and Environmental Chemistry TXECBP, Vol. 24, No. 3, p 171-180, 1989. 4 fig, 5 tab, 26 ref.

Descriptors: *Coastal waters, *Water pollution effects, *Red tide, *Eutrophication, *Aegean Sea, Wastewater pollution, Species composition, Species diversity, Nutrients, Gymnodinium, Pagassitikos Gulf, Phytoplankton, Dinoflagellates, Diatoms.

The abundance, species composition and taxonomic diversity of phytoplankton was studied in relation to sewage pollution north of the Pagassitikos Gulf, Greece. Surface water samples were collected from a series of stations in the Gulf during July 1987. Samples were preserved, concentrated by settling, and the concentration of each species of phytoplankton enumerated in an inverted microscope. Water samples from the vicinity of the major sewer outfalls showed very high concentrations of nutrients, greater total concentration of phytoplankton, and a lower taxonomic diversity than samples remote from outfalls. Phytoplankton abundance and taxonomic diversity depend upon the supply of nutrients in natural waters, where abundance increases and diversity decreases with increasing nutrient concentrations in the Pagassitikos Gulf. A considerable variation in the occurrences of species and dominance occurred along the nutrients pollution gradient. Dinoflagellates were dominant in polluted waters, while diatoms dominated in cleaner water away from major sewage outflow. From the dominance and relative distribution of the taxa along the pollution gradient certain species of Gymnodinium emerge as indicator species of red tide pollution. These changes correspond to a typical degradation of a complex community to a less mature state by the inflow of nutrient-rich sewage (eutrophication) in the north Pagassitikos Gulf. (Author's abstract)
W90-02223

EFFECTS OF SIMULATED ACID PRECIPITATION ON THE METABOLIC ACTIVITY OF CLADINA STELLARIS.
Ecole Polytechnique, Montreal (Quebec). Section du Genie de l'Environnement.
For primary bibliographic entry see Field 2K.
W90-02237

EFFECTS OF TEMEPHOS ON ZOOPLANKTON COMMUNITIES IN ENCLOSURES IN A SHALLOW EUTROPHIC LAKE.
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.
T. Hanazato, T. Iwakuma, M. Yasuno, and M. Sakamoto.
Environmental Pollution ENPOEK, Vol. 59, No. 4, p 305-314, 1989. 3 fig, 1 tab, 19 ref. Ministry of Education, Science and Culture, Japan Special Project Research No. 61134044 .

Descriptors: *Eutrophic lakes, *Insecticides, *Water pollution effects, *Pesticides, *Zooplankton, Temephos, Organophosphorus pesticides, Species composition, Rotifers.

An organophosphorus insecticide, temephos, was applied to large-volume (105 cubic meters) enclosures set up in a shallow eutrophic lake. Application of the chemical at a target concentration of 500 microgram/liter eliminated almost all zooplankters. No recovery of cladocerans was evident at the termination of the experiment (47th day after the treatment). Copepods showed a slight recovery after having been absent for 26 days in one enclosure and 40 days in another. The residual chemical remaining in the water until the final day may have suppressed the recovery of the crustacean zooplankters. The rotifer community was reconstructed 16-20 days after the treatment. However, the species composition of this community differed from that of the rotifer community in the control enclosures. Rotifer species might therefore show differences in susceptibility to temephos. (Author's abstract)
W90-02240

EFFECTS OF SIMULATED RAIN ACIDITY ON ECTOMYCORRHIZAE OF RED SPRUCE SEEDLINGS POTTED IN NATURAL SOIL.
North Carolina State Univ. at Raleigh. Dept. of Plant Pathology.
For primary bibliographic entry see Field 2K.
W90-02241

FRESHWATER SHRIMP (PARATYA COMPRESSA IMPROVISA) AS A SENSITIVE TEST ORGANISM TO PESTICIDES.
National Inst. for Environmental Studies, Ibaraki (Japan). Environmental Biology Div.
For primary bibliographic entry see Field 5A.
W90-02242

TOXICITY OF LEAD TO CLARIAS LAZERA, OREOCHROMIS NILOTICUS, CHIRONOMUS TENTANS AND BENACUS SP.
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Biological Sciences.
A. A. Oladimeji, and B. O. Offem.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 191-201, April 1989. 3 fig, 4 tab, 25 ref.

Descriptors: *Bioassay, *Bioaccumulation, *Toxicity, *Lead, *Water pollution effects, Oreochromis, Clarias, Chironomus, Midges, Fish physiology, Macroinvertebrates, Benacus.

The 48-hour LC50 value of Pb (Pb(NO3)2) with Oreochromis niloticus was 3.34 mg/L and the 96-hour LC50 was 2.15 mg/L, compared with 1.91 mg/L at 48 hours and 1.72 mg/L at 96 hours for Clarias lazera. Chironomus tentans larvae demonstrated 48-hour LC50 of 2.68 and Benacus LC50 was 1.89,mg/L. The 96-hour LC50 value was 1.77 mg/L for Chironomus and 1.36 mg/L for Benacus. Clarias appeared to be the most susceptible of the four to Pb poisoning; Chironomus was the least susceptible. Uptake pattern of Pb by fingerlings of Oreochromis niloticus and Clarias lazera exposed to 0.33 and 0.27 mg/L Pb, respectively, and the clearance of accumulated Pb were curvilinear. There was an initial fast phase of accumulation occurring during the first 96 hours, followed by a slower phase over the remaining 240 hours. Mean Pb concentrations in O. niloticus were 33.30 micrograms/g in the gills, 22.2 microgram/g in intestine, 5.3 microgram/g in liver, 2.8 microgram/g in muscle, 1.8 microgram/g in bone, and 14.9 microgram/g in whole body. Mean Pb concentrations in C. lazera were 28.7 microgram/g in gills, 6.5 in intestine, 11.5 in liver, 2.5 in muscle, 5.6 in bone, 5.9 in skin, and 6.8 microgram/g in whole body. The half-life of Pb in Oreochromis was 20 hours, compared with 43 hours in C. lazera. Bioconcentration factors in Oreochromis were 78.3 and in Clarias, 33.8. The data suggest that O. niloticus accumulates and eliminates Pb faster than C. lazera. (Author's abstract)
W90-02257

DETERMINATION AND REDUCTION OF PHYTOTOXICITY OF TWO INDUSTRIAL WASTE EFFLUENTS.
Illinois State Water Survey, Peoria. Water Quality Section.
W. Wang, and J. M. Williams.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 363-373, April 1989.

Descriptors: *Chemical wastes, *Chemical treatment, *Industrial wastes, *Wastewater treatment, *Toxicity, *Bioassay, *Phytotoxicity, Seed germination, Millet, Activated carbon, Cation exchange.

Phytotoxicity of treated and untreated industrial effluent samples was determined using a millet seed germination test. The results of this and other studies showed that the test was reproducible and useful for effluent toxicity determination. Effluent sample I was from an industrial wastewater pretreatment plant and sample II was from a specialty chemical industry. Sample I was weakly acidic and sample II was alkaline. pH adjusted to 7-8 was found to have no effect in phytotoxin removal. Granular and powdered activated carbon effectively reduced phytotoxicity. Amberlite XAD-4 (nonionic polymeric adsorbent) and cation exchange resin had a partial effect. Anion exchange resin, silica gel, Sephadex G-75, and starch xanthate had no effect. The results showed that the millet seed germination test was useful for effluent toxicity determination. The test was simple and cost effective. Plant seeds generally have a long shelf-life and require minimum maintenance costs. All these factors make the test suitable as a complement/supplement for effluent monitoring. Activated carbon was effective in removing toxicity in Sample I. Sample II was more toxic than sample I and would require other wastewater treatment technology(ies) for toxicity removal. (Mertz-PTT)
W90-02265

ZOOPLANKTON COMMUNITIES AND ACIDIFICATION PROCESSES (A REVIEW).
Uppsala Univ. (Sweden). Limnologiska Institutionen.
M. T. Brett.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 387-414, April 1989. 4 tab, 102 ref.

Descriptors: *Acidic water, *Water pollution effects, *Zooplankton, *Lakes, *Acid rain effects, Daphnids, Waterfleas, Copepods, Chaoborids, Crustaceans, Rotifers, Hydrogen ion concentration, Physiology, Aluminum.

A review of the literature that deals with the zooplankton of acid-stressed ecosystems revealed several strong patterns, weaker patterns, areas of controversy or inconsistency, and poorly understood but potentially important factors. Those patterns that were strong, but not necessarily universal, included a general response to short-term pH shocks suggesting that daphnids were least tolerant followed by other cladocerans, copepods, and chaoborids. In addition, the numbers of both crustacean and rotifer species were decreased, and the importance of daphnids was reduced in acidic lakes, while limnetic hemipterans were greatly increased in acidic fishless lakes. Weaker patterns included reduced zooplankton biomass, reduced importance of cyclopoids, and increased representation of generalist species in acidic lakes, and intraspecies differences in pH tolerance indicating that populations of acid-stressed ecosystems were more tolerant. But, zooplankton biomass was apparently a result of system productivity as opposed to pH per se. Inconsistencies within the literature existed as to whether chaoborids were more abundant in acidic fishless lakes, the influence of physiological stress contra predation in determining community structure, the immediate response of the zooplankton to lake neutralization, and the toxicity of Al. The importance of metals, humic substances, and the fauna in determining community dynamics was poorly understood. Although both phytoplankton and zooplankton communities could be severely simplified in acidic lakes, the influence of the phytoplankton on the zooplankton, beyond the relation edible biomass vs. zooplankton standing stock, in these ecosystems was unclear. From the literature it is apparent that direct physiological influences of acid-stress are important, but that indirect (biotic) influences and variables that correlate with pH are often as important if not more so to the zooplankton. (Author's abstract)

W90-02266

EFFECT OF TEMPERATURE ON ZOSTERA MARINA L (PART 3) CHANGE OF THE LIFE-CYCLE BY A RISE IN TEMPERATURE, (IN JAPANESE).
Central Research Inst. of Electric Power Industry, Tokyo (Japan).
Y. Kawasaki.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-753866/GAR. Price codes: A03 in paper copy, A01 in microfiche. CRIE-U-87046, December 1987. 26p, 16 fig, 3 tab, 15 ref. English summary.

Descriptors: *Sea grasses, *Water pollution effects, *Thermal pollution, *Temperature effects, *Japan, Macrophytes, Life cycles, Plant growth, Zostera, Eelgrass, Odawa Bay.

In order to obtain basic information and to predict the influence of thermal effluent from powerplants on eelgrass beds, an indoor experiment was conducted to study the influence of temperature on the life cycle of eelgrass (Zostera morina) using Odawa Bay as a model. Results were as follows: (1) Seed germination was retarded by temperature increase and the germination rates were reduced at a temperature increase of 6 degrees C (min. water temperature 18 C); (2) Survival rate of transplants at temperature +3 C in the summer experiment (max. water temperature 29 C) and +9 C in the winter (min. temperature 21 C) experiment were significantly lower than for the control. All of the shoots died at temperature +6 C in the summer experiments; and (3) The change of vegetative shoots to flowering shoots was inhibited by a temperature rise of +3 C (min. water temperature 15 C). From these results, it was inferred that the life cycle of Zostera in Odawa Bay will be affected when temperature increases by +3 C or greater both in summer and winter. (Author's abstract)
W90-02274

EFFECT OF THE HEAVY METALS LEAD, CADMIUM, AND MANGANESE ON THE FRESHWATER GREEN ALGAE CHLAMYDOMONAS REINHARDII DANGEARD AND CHLORELLA FUSCA SHIHIRA AND KRAUSS: COMPARATIVE INVESTIGATION OF THE ACCUMULATION, TOXICITY, AND ULTRACYTOCHEMICAL LOCALIZATION OF HEAVY METALS (DIE WIRKUNG DER SCHWERMETALLE BLET, CADMIUM UND MANGAN AUF DIE SUSSWASSERGRUENALGEN CHLAMYDOMONAS REINHARDII DANGEARD UND CHLORELLA FUSCA SHINIRA ET KRAUSS: VERGLEICHENDE UNTERSUCHUNGEN ZUR ANREICHERUNG, TOXIZITAET UND ULTRACYTOCHEMISCHEN LOKALISATION).
Hamburg Univ. (Germany, F.R.). Fachbereich Biologie.
U. Irmer.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-772070/GAR. Price codes: A08 in paper copy, A01 in microfiche. NP-870270, May 1982. 169p, 28 fig, 13 tab, 48 ref. English summary.

Descriptors: *Path of pollutants, *Water pollution effects, *Heavy metals, *Algae, *Bioaccumulation, *Toxicity, Lead, Cadmium, Manganese, Chlamydomonas, Chlorella, Continuous culture.

Batch cultures of algae were raised in a turbidostat. In all experiments, pure algal material from continuous cultures was used. Testing was done for concentration dependence of cadmium and manganese uptake and for the toxicity of these elements and of lead. With various combinations of the studied metals, both synergistic and antagonistic effects occurred. The growth reduction caused by lead, cadmium, and manganese in cultures of Chlamydomonas reinhardii correlated with serious cell damage. The toxicity investigations gave additional information about the mode of action of cadmium and manganese on algae. Cadmium inhibits the sporulation of C. reinhardii and Chlorella fusca; manganese diminishes the average cell volume. (Shidler-PTT)

W90-02279

ESTIMATING TOXICITY OF INDUSTRIAL CHEMICALS TO AQUATIC ORGANISMS USING STRUCTURE ACTIVITY RELATIONSHIPS.
Environmental Protection Agency, Washington, DC. Office of Toxic Substances.
R. G. Clements, D. W. Johnson, R. L. Lipnick, J. V. Nabholz, and L. D. Newsome.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-117592. Price codes: A10 in paper copy, A01 in microfiche. Report No. EPA-560-6-88-001, July 1988. 287p, 81 tab.

Descriptors: *Water pollution effects, *Toxicity, *Aquatic life, *Chemical wastes, *Structure-activity relationships, Organic compounds, Surfactants, Polymers, Invertebrates, Algae, Aquatic animals.

Forty-nine structure activity relationships (SARs) are presented which are currently used by the Environmental Effects Branch of EPA to estimate the toxicity of industrial organics to aquatic organisms. These SARs can be applied to three broad categories of organic chemicals: (1) neutral organics which are non-reactive and non-ionizable, (2) neutral organics which are reactive and show excess toxicity in addition to narcosis, and (3) surface active organic compounds such as surfactants, and polycationic polymers. There are about 40 classes and sub-classes of organic compounds covered by these SARs. The scope of the SARs includes acute toxicity to vertebrates and invertebrates (freshwater and saltwater species), chronic toxicity to freshwater vertebrates and invertebrates, and toxicity to freshwater algae. (Author's abstract)
W90-02313

COASTAL POLLUTION--AESTHETICS AND/OR HEALTH.
Coastal Antipollution League, Ltd.
J. A. Wakefield.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 45-55, 1 fig, 1 tab, 7 ref.

Descriptors: *Wastewater disposal, *Water pollution effects, *England, *Wales, *Coastal waters, Public health, Coastal Anti-Pollution League, Domestic wastes, Waste disposal, International agreements, Ocean dumping, Swimming, Recreation.

An outline is presented of the circumstances leading to the formation of the Coastal Anti-Pollution League in 1958, whose principal objectives are: (1) to promote the prevention of contamination of the tidal waters and pleasure beaches around England; and (2) to promote the advancement of education in the science of sewage disposal. How the medical controversy (whether coastal waters are in fact a public health risk), together with the difficulty of obtaining information, has delayed any action to reduce coastal pollution, and how the Golden List of Beaches in England and Wales has influenced public opinion, is discussed. The case for a public watchdog is made, along with the need for better education in the disposal of human waste. The Golden List of Beaches first published in 1960, was an attempt to publicize beaches that were considered safe for bathing. However, many years of research have not revealed a causal relationship between swimming in sewage polluted seawater and serious disease, such as polio or typhoid. A tenuous connection has been made between mean enterococcus density and gastroenteritis. The European Directive on the Quality of Bathing Water does set a bacteriological standard based on total and fecal coliform. Most Water Authorities have accepted the need to comply with the requirement in this Directive. (See also W90-02317) (Lantz-PTT)
W90-02321

MONITORING FOR ENVIRONMENTAL IMPACT.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5A.
W90-02331

OIL DISPERSANTS: NEW ECOLOGICAL APPROACHES.
For primary bibliographic entry see Field 5G.
W90-02334

EFFECTS OF CHEMICAL DISPERSANT AGENTS ON THE BEHAVIOR AND RETENTION OF SPILLED CRUDE OIL IN A SIMULATED STREAMBED CHANNEL.
Science Applications International Corp., San Diego, CA.
For primary bibliographic entry see Field 5G.
W90-02335

DISPERSANTS IN THE FRESHWATER ENVIRONMENT.
Esso Resources Canada Ltd., Calgary (Alberta).
H. M. Brown, and R. H. Goodman.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 31-40, 1 fig, 2 tab, 10 ref.

Descriptors: *Oil dispersants, *Dispersants, *Environmental effects, *Cleanup operations, *Oil spills, Oil pollution, Water pollution treatment, Ecological effects, Toxicity, Lakes, Fens, Aquatic plants, Bioassay, Lethal limit.

During the past four years, a research program to investigate the effect of oil and dispersant chemicals on a freshwater ecosystem has been carried out. Laboratory experiments were used to select a suitable dispersant for a field trial and to develop monitoring techniques which would be capable of detecting chronic and sublethal effects in selected species of the freshwater ecosystem (specifically: mosses, lichens, sedge, willow, daphnia, gammarus, algae, and trout). A general conclusion of the contributors to this project was that the oil spills had only a temporary effect on either of the two fen lakes studied. No oil was observed on the surface of the dispersant treated lake after a few days, although it persisted for more than a month on the lake in which only oil was added. Damage to shoreline and floating aquatic plants occurred in both lakes but was more severe in the oil only lake. New growth was observed one month after the spill in both lakes. Submerged aquatic plants appeared unaffected in either lake. Measurements of total organic carbon, nitrogen, phenols, and surfactants did not reveal any significant differences among the three lakes during the field tests. Neither Microtox or 96-hr trout assays detected any toxicity of the fen waters. Indigenous bacterial populations and activities showed little change on either of the oiled lakes, although some enrichment of hydrocarbon degraders was observed. Plankton density, biomass, and productivity was unaffected. One year after the spills, no apparent difference could be detected between the two oil treated lakes, or between these lakes and the control lake. Seasonal regrowth appeared to be normal in all three. (See also W90-02334) (Lantz-PTT)
W90-02337

USE OF CHEMICAL DISPERSANTS TO CONTROL OIL SPILLS IN SHALLOW NEARSHORE WATERS.
McAuliffe (Clayton) and Associates, Fullerton, CA.
For primary bibliographic entry see Field 5G.
W90-02339

TROPICAL OIL POLLUTION INVESTIGATIONS IN COASTAL SYSTEMS (TROPICS): THE EFFECTS OF UNTREATED AND CHEMICALLY DISPERSED PRUDHOE BAY CRUDE OIL ON MANGROVES, SEAGRASSES, AND CORALS IN PANAMA.
RPI International, Inc., Columbia, SC.
T. G. Ballou, R. Dodge, S. Hess, and A. Knap.
IN: Oil Dispersants: New Ecological Approaches.

STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 229-256, 8 fig, 9 tab, 10 ref.

Descriptors: *Water pollution treatment, *Oil dispersants, *Oil pollution, *Water pollution effects, *Dispersants, *Tropical regions, Chemical treatment, Environmental effects, Oil spills, Case studies, Hydrocarbons, Mangrove swamps, Corals, Sea grasses, Fauna, Flora.

A multidisciplinary long-term field experiment was conducted to evaluate the use of chemical dispersants as a means of reducing adverse environmental effects of oil spills in nearshore, tropical waters. Three study sites whose intertidal and subtidal components consisted of mangroves, sea grass beds, and coral reefs were studied in detail before, during, and after exposure to untreated crude oil or chemically dispersed oil. This study was intended to simulate an unusually high, worst-case exposure level of dispersed oil and a moderate exposure level of untreated oil. The third site served as an untreated reference site. Assessments were made of the distribution and extent of contamination by hydrocarbons over time, and the short-term and long-term effects on survival, abundance, and growth of the dominant flora and fauna of each habitat. The whole, untreated oil had severe, long-term effects on survival of mangroves and associated fauna and relatively minor effects on sea grasses, corals and associated organisms. Chemically dispersed oil caused declines in the abundance of corals, sea urchins, and other reef organisms; reduced coral growth rate in one species; and had minor or no effects on sea grasses and mangroves. Conclusions can then be drawn from these results with respect to decision making at the site of the actual spills, based upon trade-offs on the consequences of dispersing or not dispersing the oil. (See also W900-02334) (Author's abstract)
W90-02355

DISPERSED OIL EFFECTS ON TROPICAL NEARSHORE ECOSYSTEMS.
Greater Caribbean Energy and Environment Foundation, Miami, FL.
A. Thorhaug.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 257-273, 6 fig, 5 tab, 23 ref.

Descriptors: *Water pollution treatment, *Oil dispersants, *Ecological effects, *Water pollution effects, *Oil spills, *Dispersants, *Cleanup operations, Chemical treatment, Tropical regions, Fisheries, Sea grasses, Corals, Mangrove swamps, Corexit, Toxicity, Biological studies.

Tropical and subtropical critical habitats are generally more fragile and slower to recover than temperate ones in which the environmental standards and guidelines are made. Fishery nurseries are found immediately adjacent to shore in sea grass in the tropics, unlike temperate zones where fisheries are most frequently offshore and much of the adult fish catch is in this coastal region (the exceptions are a few migrating fish such as tuna). Many studies have dealt with oil effects on corals and mangroves; fewer have dealt with sea grass. Very few studies have looked at dispersed oil on any of these habitats. The single dispersant used for mangroves and corals and the primary dispersant in sea grass studies was Corexit 9527, which showed no mortality on subtropical and tropical habitat species between 1 to 50 parts per million (ppm) for short (4 to 6 hr) time periods. Higher concentrations of dispersed oil tested on sea grasses showed ranked sensitivity. The time of exposure and concentration of dispersants are important to increasing toxicity effects. Four species of corals were tested using Corexit 9527 concentrations from 1 to 50 ppm. Little difference in response was apparent. For mangroves, only the Western Atlantic red mangrove has been tested for the dispersant Corexit 9527. The Indo-Pacific basin critical habitat species and Arabian Red Sea species need similar testing for 'safe limits.' These results indicate field testing of various dispersants is necessary, and regulators and planners should stop using the generic 'dispersants' in oil spill contingency planning and name the substance tested in their ecosystems since some dispersants are toxic and others are not. (See also W90-02334) (Author's abstract)
W90-02356

SYNTHESIS OF EFFECTS OF OIL ON MARINE MAMMALS.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-117451. Price codes: A14 in paper copy, A01 in microfiche. Report No. MMS 88-0049, September 1988. 291p. Edited by J. R. Geraci and D. J. St. Aubin.

Descriptors: *Oil pollution, *Water pollution effects, *Marine mammals, *Mammals, Dispersants, Literature review.

This report completes the synthesis of existing information on the effects of oil, dispersed oil, oil dispersants, and oil cleaning agents on marine mammals which migrate through or inhabit U.S. Outer Continental Shelf (OCS) planning areas. It will be used to produce a manuscript for use in OCS decision-making and serve as a general reference document for parties interested in marine mammals and oil effects research. A literature search on foreign and non-foreign literature, was conducted on topics pertaining to the natural history and oil, oil dispersant, and oil cleaning agents effects on marine mammals. All identified papers and reports were reviewed and evaluated. Results of the evaluation were then synthesized according to topic and reported upon in the manuscript. In some cases, previously unpublished data was also incorporated into the individual chapters. (See W90-02430 thru W90-02440) (Author's abstract)
W90-02429

COMPOSITION AND FATE OF PETROLEUM AND SPILL-TREATING AGENTS IN THE MARINE ENVIRONMENT.
Battelle Ocean Sciences, Duxbury, MA.
J. M. Neff.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 1-40, 8 fig, 1 tab, 22 ref.

Descriptors: *Fate of pollutants, *Oil pollution, *Marine environment, *Path of pollutants, *Water pollution effects, *Marine mammals, *Dispersants, Tar, Otters, Whales.

The chemical properties of oil ultimately determine its effects. Some compounds are actively toxic, and are damaging to delicate tissues, such as eyes, nasal cavities and other sensitive mucus membranes. Their noxious properties are balanced by rapid dissipation and removal from the environment. Many of the properties of petroleum and its behavior and fate when spilled in the marine environment make it likely that marine mammals will come in contact with oil in some form. All marine mammals spend considerable time at the surface, swimming, breathing, feeding, or resting, thereby enhancing the possibility of contact with a surface slick, water-in-oil emulsion, or tar balls. Oil would have less tendency to adhere to the surface of animals with relatively little or no pelage, such as whales, dolphins, manatees, and most seals. Marine mammals encountering fresh oil are likely to inhale volatile hydrocarbons evaporating from the surface slick. Such fractions contain toxic monoaromatic hydrocarbons (benzene, toluene, xylenes) and low molecular weight aliphatics with anaesthetic properties. Inhalation of concentrated petroleum vapors may cause inflammation of and damage to the mucus membranes of airways, lung congestion, or even pneumonia. Volatile hydrocarbons, such as benzene and toluene, that are inhaled are transferred rapidly into the bloodstream in the lungs. Excepting their use to clean oil-fouled sea otters, virtually nothing is known about the effects of oil dispersants on marine mammals. By removing spilled oil from the sea surface, dispersants obviously reduce the risk of contact. The oil remaining would be less sticky, and therefore, less likely to adhere to fur, skin, baleen plates, or other body surfaces. On the other hand, the surfactants in dispersants may remove natural oils from marine mammal fur, thereby decreasing its insulating properties. Cleaning oiled beaches and rocky shores with dispersants may be an effective means of preventing oiling of pinnipeds that may wish to haul out there. More work needs to be done before the advantages or disadvantages of using dispersants in such habitats can be adequately weighed. (See also W90-02429) (Lantz-PTT)
W90-02430

PINNIPEDS AND OIL: ECOLOGIC PERSPECTIVES.
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Biology.
L. A. McLaren.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 41-119, 20 fig, 7 tab, 162 ref.

Descriptors: *Oil pollution, *Water pollution effects, *Marine mammals, Pinnipeds, Population dynamics, Seals, Walruses, Literature review, Oil spills, Ecological effects.

The three major kinds of pinnipeds are the hair seals, the otariid seals (fur seals and sea lions) and the walrus. Hair seals, walruses and sea lions have short hair coats, especially sparse in the walrus. They are protected from excessive heat loss in part by a thick layer of blubber. Fur seals, have a particularly dense underfur to trap air for insulation. Both blubber and thick fur are disadvantages at high temperatures; with a few notable exceptions, pinnipeds are found in temperate-to-polar regions. A oil pollution effects should be measurable by determining population changes. The large populations and wide geographic distributions of most pinnipeds insulate them from extinction by any conceivable effect of oil pollution. However, local populations may be less secure. An empirical and theoretical literature is being developed on the subject of extinction, particularly in the context of rare, localized populations or species and the design of biological reserves. A different kind of threat comes from the remote chance of catastrophic accident with direct, acute mortalities. This could be particularly serious in small, localized populations, already close to the level where 'chance' might settle their fate. The role of chance in extinction has long attracted theoretical enquiry. Clearly, pollution can contribute to the variability of environments in which pinnipeds live. There is great resilience of long-lived species like pinnipeds to normal seasonal or other short-term fluctuations. However, long-term, lower-amplitude fluctuations, whether natural or anthropogenic, might be more 'attuned' to the life-cycle characteristics of pinnipeds. If it is taken as a premise that an oil pollution catastrophe has produced a large kill of pinnipeds, it is important to consider the rate at which the population is restored to its original level. Indeed, rate of return to 'normality' is often an explicit component of environmental impact statements. The rate of recovery depends on the species and circumstances. Pinnipeds populations could recover at rates of 7-17%/yr, provided they were well below equilibrium levels before the catastrophe. Those closer to equilibrium should show an enhanced rate of increase following substantial reduction of numbers. However, individuals raised under the stress of overcrowding may not be capable of producing an immediate population response. (See also W90-02429) (Lantz-PTT)
W90-02431

PHYSIOLOGIC AND TOXICOLOGIC EFFECTS ON PINNIPEDS.
Ontario Veterinary Coll., Guelph. Dept. of Pathology.
D. J. St. Aubin.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 120-142, 2 fig, 1 tab, 74 ref.

Descriptors: *Marine mammals, *Seals, *Water pollution effects, *Oil pollution, *Physiological ecology, Toxicity, Ecological effects, Oil spills, Mortality, Literature review, Ecological effects.

Oil fouling has been implicated in the deaths of pinnipeds, though much of the evidence has been circumstantial. Large-scale mortality has occurred

rarely, even after some of the more catastrophic spills. In general, the prediction that spilled oil would have its greatest impact on young pinnipeds in cold, ice-bound waters has been borne out following the discharge of residual oil in the Gulf of St. Lawrence in 1969. Pinnipeds are not unduly sensitive to the noxious characteristics of oil. Incidental ingestion during feeding, exposure to vapor concentrations that might be expected under natural conditions at sea, and surface fouling with relatively fresh oil do not appear to cause significant distress. Pinnipeds trapped near the source of a spill, or forced to emerge in heavy accumulations of oil in leads and around rookeries will undoubtedly exhibit the most severe effects. For fur seals, experimental studies indicate that surface fouling will decrease the insulative value of the pelt, possibly leading to thermal and energetic stress. Individuals of all species and groups that are compromised by pre-existing disease, or stressed by pressures of an unfavorable habitat, intra-specific competition, or unusual environmental conditions may be the most sensitive to the effects of oil exposure. (See also W90-02429) (Lantz-PTT)
W90-02432

CETACEANS AND OIL: ECOLOGIC PERSPECTIVES.
Moss Landing Marine Labs., CA.
B. Wursig.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 143-166, 5 fig, 124 ref.

Descriptors: *Oil pollution, *Water pollution effects, *Marine mammals, Literature review, Ecological effects, Dolphins, Whales, Cetaceans, Porpoises.

The order Cetacea is divided into two suborders: the mysticetes or baleen whales and the edontocetes or toothed whales, dolphins, and porpoises. Many aspects of cetacean behavior, diet and habitat use may lead them into contact with spilled oil. Species that occur in restricted areas for at least a part of their lives are more likely to encounter oil than those that range widely. Examples are breeding and feeding humpback, gray, right, bowhead, and beluga whales, narwhals, bottlenose dolphins, harbor porpoises, and river dolphins. Cetaceans with vast ranges may contact some oil as they move quickly through a fouled area, but with little potential for long-term exposure. Cetaceans that feed either at the surface or at the bottom are more likely to contact oil than those that generally feed in the water column. These include skim-feeding right and bowhead whales, surface-lunging rorquals, and the bottom-feeding gray whales. Harbor porpoises and some dolphins may contact oil at times, when they feed on flatfish and other bottom-dwelling prey. Dolphins that habitually force schools of prey to the surface may also be at risk. As a group, baleen whales appear to be the most vulnerable in view of low regulation sizes in some (right and bowhead), feeding strategies generally, and abundance on selected, restrictive habitats for feeding and reproduction. Among the odontocetes of the North American Continental Shelf, restrictive habitat increases the risk of exposure for belugas, narwhals, harbor porpoises and bottlenose dolphins. For the most part, other toothed whales and dolphins are too mobile for oil to present much of a threat. (See also W90-02429) (Lantz-PTT)
W90-02433

PHYSIOLOGIC AND TOXICOLOGIC EFFECTS ON CETACEANS.
Ontario Veterinary Coll., Guelph. Dept. of Pathology.
J. R. Geraci.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 167-202, 6 fig, 1 tab, 94 ref.

Descriptors: *Marine mammals, *Water pollution effects, *Physiological ecology, *Oil pollution, *Whales, Toxicity, Cetaceans, Volatile organic compounds, Dolphins, Oil spills, Literature review, Tar, Ecological effects, Porpoises.

An oil spill at sea would add an element of risk to the environment of a whale or dolphin. Fresh crude oil or volatile distillates release toxic vapors that can damage sensitive tissues, harmful fractions may be swallowed or consumed through contaminated prey, and thicker tarry substances with entrapped debris linger at the surface, threatening to plug the vital baleen and digestive apparatus of whales that engulf them. In spite of numerous spills in which cetaceans have been observed at sea, none of these effects has been detected, or recorded at least with any certainty. Experimental evidence shows that dolphins can see oil at the surface; they can also feel it, and prefer to avoid it. Other cetaceans seem to be comparably equipped to detect oil, yet in the wild, whales and dolphins have been observed swimming and feeding in its presence, without apparent ill effect. Unlike furbearers, there is no avenue for uncontrolled heat loss through fouling of the skin. Though encounters are likely, there is no evidence that oil or tar balls foul the feeding apparatus of baleen whales, and laboratory studies suggest such an effect would be transient. On the whole, it is quite improbable that a species or population of cetaceans will be disabled by a spill at sea, whatever the likelihood that one or a few animals might be affected or even killed. Yet, some habitats and, therefore, their residents, are more vulnerable than others. The ice-edge, refuge for bowheads, narwhals and beluga whales, is a riskier trap than pelagic waters. And coastal areas with bustling oil production activity might see dolphins as the unwitting sentinals of a deteriorating environment. The stage is now set for decisions to identify, wisely utilize, and monitor such habitats. (See also W90-02429) (Lantz-PTT)
W90-02434

SEA OTTERS AND OIL: ECOLOGIC PERSPECTIVES.
National Zoological Park, Washington, DC. Office of Zoological Research.
K. Ralls, and D. B. Siniff.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 203-215, 1 fig, 54 ref.

Descriptors: *Sea otters, *Otters, *Marine mammals, *Oil pollution, *Water pollution effects, Toxicity, Literature review, Physiological ecology, Ecological effects, Animal behavior.

Many features of an otter's life history may predispose it to exposure to spilled oil. They show strong site fidelity within a well-defined range. Circumstances often bring them together to form loose associations, or rafts, sometimes numbering a hundred or more otters. Thus there exists the possibility that a relatively large group of animals might be exposed simultaneously. The effect on the population as a whole would not necessarily be irreversible, in as much as such rafts are composed mostly of non-breeding males. However, breeding males and females which congregate in smaller groups show even greater attachment to a defined territory. Such animals, while vulnerable, are also crucial to the viability of the population. Particularly vulnerable is the newborn otter which is entirely dependent on its mother during the first few months of its life. It is left unattended and virtually helpless at the surface while the mother dives in search of food. The prey that she seeks and may retrieve for her pup are those that accumulate and store hydrocarbon residues from contaminated sediments. In typical otter fashion, the mother may surface some distance from where she submerged, perhaps in a kelp bed which has entrapped oil. Once contaminated, an otter's normal preoccupation with grooming may become obsessive, displacing other behaviors, including feeding and resting. Despite the effort, the otter has only a small chance of restoring the insulative value of its coat. (See also W90-02429) (Lantz-PTT)
W90-02435

PHYSIOLOGIC AND TOXICOLOGIC EFFECTS ON SEA OTTERS.
Ontario Veterinary Coll., Guelph. Dept. of Pathology.
J. R. Geraci.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 216-224, 25 ref.

Descriptors: *Oil pollution, *Water pollution effects, *Otters, *Toxicity, *Marine mammals, Literature review, Physiological ecology, Animal behavior.

Oil poses the greatest threat to marine mammals with hair or fur; of these mammals the otter is clearly the most vulnerable. They are small, highly energetic and cannot tolerate interruptions in feeding. The dense hair coat, an ideal matrix for retaining oil, must be kept groomed, and therefore free of oil to maintain its thermal insulative value. One that might escape the consequences of ingesting oil while grooming a fouled coat, might later be exposed to systemic effects by eating contaminated prey. Their vulnerability is compounded by their behavior as a group, which tends to fix them in an area, whether or not it contains oil. An displacement, whether by their own response, or through well-meaning intervention, does not necessarily guarantee survival. (See also W90-02429) (Lantz-PTT)
W90-02436

POLAR BEARS AND OIL: ECOLOGIC PERSPECTIVES.
Canadian Wildlife Service, Edmonton (Alberta).
I. Stirling.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 225-238, 2 fig, 22 ref.

Descriptors: *Marine mammals, *Oil pollution, *Water pollution effects, Ecological effects, Literature review, Predators, Animal behavior, Physiological ecology, Polar bears, Oil spills.

Unlike seals or whales, polar bears have not evolved the ability to stay underwater for prolonged periods. Nor have they developed webbing between their toes like sea otters, or other morphological adaptations typical of pinnipeds or cetaceans. Yet polar bears spend as much of the year as possible on sea ice, and are completely dependent on the sea for their existence. The way in which a bear gathers food, the characteristics of its environment, and its migratory behavior are all potentially capable of bringing it in contact with spilled oil. The animal is closely associated with ice floes–the same type of environment which entrains, concentrates, and moves surface oil, and retards its degradation and elimination. Polar bears share with sea otters, the need to maintain a pristeen hair coat as protection against heat loss. Consequently, exposure under any of these conditions is likely to be deleterious. (See also W90-02429) (Lantz-PTT)
W90-02437

PHYSIOLOGIC AND TOXICOLOGIC EFFECTS ON POLAR BEARS.
Ontario Veterinary Coll., Guelph. Dept. of Pathology.
D. J. St. Aubin.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 239-245, 1 fig, 6 ref.

Descriptors: *Toxicity, *Marine mammals, *Water pollution effects, *Polar bears, *Oil pollution, Physiological ecology, Animal behavior, Predators.

More than any other marine mammal, polar bears scavenge food, and are likely to manipulate and consume an oil-soaked seal or bird carcass. They show no particular aversion to the taste of oil, judging from studies of their behavior in the wild. This is further supported by the reaction of two study bears when placed in a holding cage previously occupied by an oil-fouled bear. Both became preoccupied with cleaning their lightly soiled paws, then turned their attention to the cage itself, actively licking oil residues from the bars and floor. For polar bears, the problems associated with ingesting fresh oil far outweigh the risks of consuming trace amounts of petroleum hydrocarbons in the tissues of their prey. Perhaps the most important lesson from studies regarding the oiling

of polar bears relates to the role of stress in determining the ultimate effects of oil exposure. Taken alone, it is conceivable that a 500 kg bear might ingest a liter or more of oil without serious consequences. Yet, the same quantity in an animal stressed by inadequate diet or other unusual environmental conditions could be fatal. Seasonal and annual fluctuations in prey abundance might greatly alter the condition of free-ranging bears, making them more likely to seek contaminated prey, and predisposing them at such times to the most severe consequences of oil exposure. (See also W90-02429) (Lantz-PTT)
W90-02438

OIL EFFECTS ON MANATEES: EVALUATING THE RISKS.
Ontario Veterinary Coll., Guelph. Dept. of Pathology.
D. J. St. Aubin, and V. Lounsbury.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 246-258, 1 fig, 1 tab, 37 ref.

Descriptors: *Water pollution effects, *Oil pollution, *Marine mammals, Manatees, Literature review, Ecological effects, Environmental effects, Animal behavior, Tar.

Unique anatomical and physiological traits distinguish manatees from other marine mammals, as does their herbivorous diet. Like cetaceans, they are considered to be wholly aquatic, though they may emerge from water to browse on vegetation just above the shoreline. Manatees concentrate their activities in relatively shallow water, and often rest at or just below the surface, behaviors that would bring them into contact with spilled oil. As in other marine groups, it is presumed that exposure to petroleum would irritate eyes and sensitive mucus membranes. Their pelage is limited to sparse sinus hairs which may have some role in cutaneous perception. Coating of these structures with oil would not likely result in significant impairment, to a degree that would overshadow the more realistic threat of irritated eyes and lungs. Judging from their relatively non-selective feeding habits, it is not inconceivable that manatees might consume tar balls along with their normal diet. Despite the many opportunities for manatees to encounter tar, such occurrences are reported rarely. A manatee might also ingest fresh petroleum which some have suggested, might interfere with the secretary activity of their unique gastric glands or harm intestinal flora vital to digestion. Whether the long retention time of ingested vegetation in the gut would increase the extent of hydrocarbon absorption is another matter for speculation. The need for manatee to occupy somewhat restricted habitats, places them in a potentially vulnerable position, particularly during winter. Oil spills or any other environmental perturbation within the confines of preferred river systems and canals would likely endanger the local population. Those able to escape such an area might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil. During summer, displacement would be less detrimental since manatees are accustomed to exploiting alternative feeding areas as they deplete local vegetation. This scenario is not one likely to be associated with offshore production or transportation of petroleum. The greater risk is from coastal accidents involving fuel barges or marine storage tanks. Yet their impact would be localized, and therefore could not endanger a large segment of the population. (See also W90-02429) (Lantz-PTT)
W90-02439

EFFECTS OF OIL ON MARINE MAMMAL POPULATIONS: RESULTS OF MODEL SIMULATIONS.
Battelle Ocean Sciences, Duxbury, MA.
J. M. Neff.
IN: Synthesis of Effects of Oil on Marine Mammals. Report No. MMS 88-0049, September 1988. p 259-284, 5 fig, 3 tab, 25 ref.

Descriptors: *Water pollution effects, *Marine mammals, *Oil pollution, Population dynamics, Ecological effects, Oil spills, Model studies, Whales, Manatees, Seals, Cetaceans, Physiological ecology, Dolphins.

Over the last several years, a large number of computer models have been developed and evaluated to predict the trajectory and fate of oil spilled in the marine environment. There have been many attempts to model the population dynamics and behavior of marine mammals. Some attempts have been made to combine these two types of models to predict the risk and effects of oil exposure to these species. Three examples of these oil spill/marine mammal risk analysis models are presented. These modeling efforts indicate the possible frequency with which marine mammals will encounter oil under different spill conditions. A fractional mortality of the oil impacted pinnipeds, but not cetaceans, was inferred. These inferred mortalities provided the basis for predicting the impacts of oil on different pinniped populations, and the time required for the population to recover. Limited data from field observations indicate that the simulated mortalities due to contact with spilled oil probably are gross overestimates. The models predict that pinniped mortalities due to encounters with oil spills range from 0 to 34% of the populations. If mortality is significant, time required for recovery ranges from 1 to about 50 years. Pinnipeds are most vulnerable when they are massed on rookeries for pupping. In the few simulations involving cetaceans, instances in which whales and dolphins encountered the oil were rare and restricted to small fractions of the populations. No effects of such encounters were inferred. Effects are likely to be minimal unless the contact with oil is extensive and repeated. (See also W90-02429) (Lantz-PTT)
W90-02440

5D. Waste Treatment Processes

CHANGES IN LIGNIN DURING DIFFUSED AIR ACTIVATED SLUDGE TREATMENT OF KRAFT EFFLUENTS.
Centro de Estudios e Investigaciones Tecnicas de Guipuzcoa, San Sebastian (Spain). Dept. of Environmental Studies.
L. Larrea, C. F. Forster, and D. Mele.
Water Research WATRAG, Vol. 23, No. 9, p 1073-1080, 1989. 10 fig, 2 tab, 18 ref.

Descriptors: *Pulp wastes, *Wastewater treatment, *Activated sludge process, *Lignin, *Chemical oxygen demand, Diffused air process, Aeration, Filtration, Polycondensation-adsorption, Color, Biochemical oxidation.

Diffused aeration experiments were carried out at 21 C in batch reactors containing a diluted Kraft black liquor in the presence of an acclimatized seed of activated sludge. The experiments were performed varying the aeration intensity and filterable COD, and lignin and color variations with time were determined in the course of the experiments. It was observed that filterable lignin (as absorbance at 280 nm) and COD decreased rapidly during the first 2 days. The magnitudes of the final reduction of both parameters were linearly related and increased with aeration intensity. The lignin reduction was attributed to a mechanism of polycondensation-adsorption of some lignin structures. COD reduction was additionally caused by the biodegradation of cellulosic derivatives and the biochemical oxidation of some functional groups of the lignin. These mechanisms promoted a COD reduction of 31% of the initial COD, which was independent of the aeration intensity. Filterable color reductions were found to be lower than those expected on the basis of filterable lignin reductions obtained by the polycondensation-adsorption mechanism. It was concluded that during diffused aeration activated sludge treatment of diluted Kraft black liquor, a mechanism of filterable color removal by polycondensation-adsorption of lignin structures could take place simultaneously with a mechanism of filterable color formation due to the biochemical oxidation of some functional groups of the lignin. (Author's abstract)
W90-02004

KINETIC ANALYSIS OF AERATED SUBMERGED FIXED-FILM (ASFF) BIOREACTORS.
Kuwait Univ., Safat. Dept. of Civil Engineering.
M. F. Hamoda.
Water Research WATRAG, Vol. 23, No. 9, p 1147-1154, 1989. 8 fig, 1 tab, 26 ref. State of Kuwait Research Project EPC 002.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Aeration, Mathematical models, Monod growth kinetics, Retention time, Chemical oxygen demand, Organic wastes.

Performance data from the four-stage, aerated submerged fixed-film reactor treating a synthetic carbonaceous wastewater showed that the specific substrate removal rate is a hyperbolic function of removal in the first stage but first-order kinetics were more applicable in the later stages where substrate concentration is low. A steady-state mathematical model with substrate-limiting phenomena based on Monod growth kinetics can successfully describe reactor performance and biomass growth. Solids retention time was found to be a function of hydraulic retention time and organic loading rate with the incorporation of a washout factor. The application of the model in the step increase of the influent COD concentration or the step increase of the influent flow rate was verified experimentally for all disturbances. The reactor showed a moderate response to disturbances of up to 50% step-increase in influence organic strength or flow rate. Reactor performance was fairly stable under these disturbances. (Author's abstract)
W90-02012

ADSORPTION OF HEAVY METAL IONS ON CARBONACEOUS MATERIAL DEVELOPED FROM THE WASTE SLURRY GENERATED IN LOCAL FERTILIZER PLANTS.
Roorkee Univ. (India). Dept. of Chemistry.
S. K. Srivastava, R. Tyagi, and N. Pant.
Water Research WATRAG, Vol. 23, No. 9, p 1161-1165, 1989. 6 fig, 7 tab, 8 ref.

Descriptors: *Waste disposal, *Heavy metals, *Metal complexes, *Adsorption, *Industrial wastes, Fertilizers, India, Chromium, Mercury, Lead, Copper, Molybdenum, Cadmium, Nickel, Cobalt, Zinc, Metal-finishing wastes.

The waste slurry generated in fertilizer plants in India has been converted into a cheap carbonaceous adsorbent material. A number of test tubes containing equal volumes of metal ion solution of varying concentrations were maintained at desired pH and temperature. Equal amounts (0.01 g) of activated carbon were introduced into each tube and stirred intermittently. Solutions were separated by centrifugation and the uptake of metal ions was calculated by the difference in their initial and final concentrations. This product exhibits a good adsorption potential for chromium, mercury, and lead, significant uptake of copper and molybdenum but is a poor scavenger for cadmium, nickel, cobalt, and zinc. Isotherms have been used to obtain the thermodynamic parameters of the process. Some column studies have also been performed with a view to recovering the metal ions and have an in situ chemical regeneration of the adsorbent material. This method can be used for the treatment of metal plating as well as metallurgical waste effluent. (Author's abstract)
W90-02014

31P-NMR SPECTROSCOPY CHARACTERIZATION OF POLYPHOSPHATES IN ACTIVATED SLUDGE EXHIBITING ENHANCED PHOSPHORUS REMOVAL.
Auburn Univ., AL. Dept. of Chemistry.
W. E. Hill, L. D. Benefield, and S. R. Jing.
Water Research WATRAG, Vol. 23, No. 9, p 1177-1181, 1989. 10 fig, 2 tab, 4 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Polyphosphates, *Phosphorus removal, Metal complexes, Sonication, Hypochlorite, Cytoplasm, Periplasmic space, Enzymatic degradation, Transport, Nucleic acids.

31P-NMR spectroscopy was employed to investigate the characteristics of polyphosphates found in activated sludge exhibiting enhanced phosphorus removal. Sonication and EDTA treatment of this sludge indicate that part of the polyphosphates accumulated are located outside the cytoplasmic membrane and are complexed with metal cations. These polyphosphates along with polyphosphatases are bound to the cell wall and/or the cytoplasmic membrane. Definitive evidence indicates that polyphosphate degradation is controlled by these immobilized polyphosphatases. Hypochlorite treatment of poly-P activated sludge produced two well resolved peaks in the polyphosphate region. No definitive explanation for the split signal can be provided. However, it is possible that it is a result of cell-bound polyphosphates located both in the periplasmic space and in the cytoplasm. The results also suggest that a portion of the inorganic phosphate released through enzymatic degradation of the polyphosphate may be involved in the transport of readily degradable organic material across the cytoplasmic membrane. It may be this pool which provides phosphorus for the synthesis of biochemical compounds such as nucleic acids. (Author's abstract)
W90-02016

UK STATE-OF-THE-ART: SEWERAGE REHABILITATION.
North West Water Authority, Warrington (England).
D. Clegg, A. R. Eadon, and D. Fiddes.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1101-1112, 1989. 2 fig, 4 tab, 11 ref.

Descriptors: *Sewer systems, *Management planning, *Sewers, *Rehabilitation, Water quality, England, Hydraulics, Economic aspects.

The problems which led to concern over the state of sewers within the UK in the 1970s are described together with the strategies and methodologies which were developed to allow cost-effective rehabilitation. Problems included a high proportion of old sewers with a history of expensive and disruptive sewer collapses, property flooding, and excessive storm sewage discharges to receiving streams. The new philosophy is to retain where practicable the existing pipework by optimizing network performance and hence avoid wholesale sewer replacement. Also the detailed investigations would be confined to the core of the system--the critical or strategic sewers--where the consequences of structural failure were most expensive and where the major flooding problems were concentrated. The strategy for the remainder--the bulk of the system of non-critical sewers--could safely remain one of reaction to failure as in the past. This approach is illustrated by reference to practice in two regional water authorities--North West Water and Severn Trent Water. Considerable benefits have accrued from considering entire pipework systems and dealing concurrently with structural, hydraulic and water quality problems. Effort in the future will concentrate on refining the existing methodology and improving business management by developing better measures of levels of service and information systems. (Author's abstract)
W90-02052

SYSTEM IDENTIFICATION AND CONTROL OF THE ACTIVATED SLUDGE PROCESS BY USE OF A STATISTICAL MODEL.
Kyoto Univ. (Japan). Dept. of Environmental and Sanitary Engineering.
M. Hiraoka, and K. Tsumura.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1161-1172, 1989. 9 fig, 1 tab, 5 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, *Control systems, Data acquisition, Statistical models, Pilot plants.

A hierarchical control system for the activated sludge system was developed which consists of an upper level system controlling long-term seasonal variations, a control system of intermediate level aiming at optimization of the process and a control system of lower level controlling diurnal changes or hourly fluctuations. A control system using a multivariable statistical model is one of the most appropriate control systems based on modern control theory for applying the lower level control of the activated sludge process. The optimum control system (which controls the air-flow rate, return sludge-flow rate, and the waste sludge-flow rate) was designed according to the following sequence of steps. First, an autoregressive (AR) model was transformed into a state-space representation. Then, a proper evaluation function is set up, and the feedback gain (G) was calculated so as to minimize the evaluation function. Using G, control was simulated to estimate the effect of control. If the effect was thought to be insufficient, the evaluation function was modified, and the calculation of G and the simulation of control were conducted again to get a proper value of G. A system identification and control experiment was then conducted in a pilot plant, and the activated sludge process control method using an AR model was examined. As a result, the system variables and data sampling interval for application of the AR model were determined. Moreover, from the prepared model, the influence of each of the manipulated variables on the controlled variables was clarified. From the control experiment, it was verified that the AR model can be used as the control model for the activated-sludge process. (Sand-PTT)
W90-02057

CONTROL OBJECTIVES AND THE MODELLING OF MLSS IN OXIDATION DITCHES.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
M. Von Sperling, and J. P. Lumbers.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1173-1183, 1989. 6 fig, 5 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, *Mixed liquor solids, *Oxidation ditches, *Control systems, Suspended solids, Dissolved oxygen, Ammonia, Biological oxygen demand, Mathematical modeling.

In order to determine the role of the adequate control of the mixed liquor suspended solids (MLSS) in the overall performance of oxidation ditches, a dynamic model, developed principally for the control of MLSS in the short term incorporating diurnal variations, was employed. The predicted model states are MLSS, return sludge suspended solids, dissolved oxygen, ammonia, sludge blanket height, effluent suspended solids and effluent BOD and the forcing functions are influent flow, suspended solids and ammonia. The simplified nature of the model makes it suitable for real time control purposes with the input variables being measurable on a continuous basis. The following simplifications were found to be acceptable: (1) Biomass growth can be regarded as constant and has little influence on the prediction of MLSS in a particular plant. MLSS variations are mainly dependent upon transport terms rather than reaction terms. (2) the effluent BOD is mainly associated with suspended solids. The soluble fraction is negligible and hence need not be modeled. (3) Since practically all influent BOD is oxidized in the reactor, the calculation of the oxygen demand can be simplified by basing this on the influent BOD load so that kinetic modeling of BOD removal is not required. The initial calibration and validation used data collected from a full-scale plant and gave satisfactory results for short-term predictions with good indications that the model is also valid for longer-term applications. (Sand-PTT)
W90-02058

SIMULTANEOUS DO CONTROL AND RESPIRATION ESTIMATION.
Lund Univ. (Sweden). Dept. of Automatic Control.
U. Holmberg, G. Olsson, and B. Andersson.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1185-1195, 1989. 6 fig, 11 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, Dissolved oxygen, Oxygen uptake, Respiration, Control systems.

The oxygen uptake rate (or respiration) is a crucial variable in the operation of an activated sludge plant. A method was developed and tried in full scale to estimate the respiration while controlling the dissolved oxygen (DO). The strategy allows a simultaneous tracking of the respiration rate and the oxygen transfer rate. This has not been possible to do in earlier methods. The control strategy is dual in the sense that the control signal, the air flow rate, is used both to control the DO concentration and to excite the DO dynamics sufficiently to allow the parameters to be estimated. The excitation is introduced automatically by a relay feedback resulting in an oscillation of the DO around its setpoint. Tuning of the relay gain makes a good compromise between fast tracking and accurate control. The dual controller and estimator was tested during a limited series of experiments in full scale at the Malmo Sewage works in Sweden. Each of two experiments lasted about three days. One experiment showed the expected low load during the weekend, while the second one showed the daily variation in the respiration rate during work days. If more measurements along the basin are used, the dual control algorithm can be extended to estimate the respiration rate profile. (Sand-PTT)
W90-02059

DISSOLVED OXYGEN CONTROL AND OXYGEN UTILIZATION RATE ESTIMATION: EXTENSION OF THE HOLMBERG/OLSSON METHOD.
Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
S. M. Bocken, M. Braae, and P. L. Dold.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1197-1208, 1989. 11 fig, 12 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, Dissolved oxygen, Oxygen uptake, Respiration, Control systems, Holmberg/Olsson method.

The Holmberg/Olsson method for simultaneous adaptive dissolved oxygen control and oxygen utilization rate estimation in the diffused air activated sludge process was evaluated. Small offsets in the parameter estimates occur because the Q/V term (Q = flow rate of stream entering/leaving reactor and V = reactor volume) is not included in the estimator model. Significant offsets may occur as a result of assumptions regarding the oxygen transfer coefficient/air flow rate relationship. The following conclusions may be drawn from the results of the evaluation of Holmberg's method for simultaneous dissolved oxygen control and parameter estimation: (1) Conditions encountered at the end of an aeration train, where the alpha (related to the oxygen transfer rate) and OUR oxygen utilization rate) parameters of the real process are near constant, indicated that under such conditions Holmberg's estimator converged rapidly and without offset to the true parameter values; (2) simulations were conducted in which the alpha and OUR parameters of the real process were assumed to vary in a sinusoidal fashion; the amplitude of the OUR fluctuation was similar to that encountered in practice at the head of an aeration train; (3) simulations in which the sampling interval ranged from 1 to 10 minutes demonstrated that Holmberg's zero-order and first-order parameter estimation techniques yield virtually indistinguishable parameter estimates and DO control for typical conditions; and (4) Holmberg's estimator assumes the flow term of the real process DO mass balance to be negligible; if the flow term is included in simulation of the real process, but excluded from the estimator model, offsets occur in the values of the parameter estimates. In all cases the dissolved oxygen control was effective. (Sand-PTT)
W90-02060

OXIDATION-REDUCTION POTENTIAL (ORP) REGULATION AS A WAY TO OPTIMIZE AERATION AND C, N AND P REMOVAL: EXPERI-

MENTAL BASIS AND VARIOUS FULL-SCALE EXAMPLES.
Compagnie Generale des Eaux, Paris (France).
J. Charpentier, H. Godart, G. Martin, and Y. Mongo.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1209-1223, 1989. 14 fig, 6 tab, 9 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, *Phosphorus removal, *Aeration, *Oxidation-reduction potential, Dissolved oxygen, Carbon, Nitrogen, Energy savings, Pilot plants.

The control of aeration by measuring the oxidation reduction potential (ORP) of activated sludge, conducted at the YFFINIAC (West of France) sewage plant in 1983, showed this type of regulation to be attractive in that it can optimize energy costs and perfect the removal of carbonaceous and nitrogenous pollutants. From a practical point of view, this new, inexpensive means of regulation has moreover proved easier to implement than the method based on measuring dissolved oxygen (DO). Before implementing this process, a pilot study was undertaken to make more accurate the ORP values for activated sludge that must be observed in order to achieve the satisfactory removal of carbonaceous and nitrogen pollutants. The ORP readings revealed points of inflection that can be used for regulation purposes. These have been related to the disappearance either of the ammonia or the nitrates with release of phosphates. The experience gained with 7 ORP regulating systems, most of them in operation for several years, and installed in works with vastly different characteristics, shows that the range of ORP values used corresponds to the pilot-scale experiments. It also shows the attractive features of the ORP signal, compared with that of DO, when used for the regulation and interpretation of the phenomena involved in the biological treatment. This type of regulation leads to improvements in the annual electricity balance and has proved to be compatible with a programmed shutdown of the aerators during the winter peak hours when the tariff per kWh is particularly expensive. The diversity of experiments on site has largely contributed towards the definition of those practical methods upon which depends the success of the system. (Author's abstract)
W90-02061

PROCESS IMPROVEMENT BY COMPUTER-AIDED LOAD SMOOTHING IN ACTIVATED SLUDGE TREATMENT.
Portsmouth Polytechnic (England). Dept. of Electrical and Electronic Engineering.
G. Haghdy, and P. Helliwell.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1225-1237, 1989. 8 fig, 2 tab, 13 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, *Control systems, *Load smoothing, Pilot plants, Energy consumption, Load smoothing, Model studies.

The benefits obtainable from smoothing flow and load to conventional activated sludge treatment units were examined in a large twin-stream pilot plant. Forecasting flow and load using ARIMA (Auto-Regressive Moving Average) models was found to lead to: (1) very marked improvement in effluent quality, particularly in concentration and load of ammonia, resulting from load smoothing of feed to a large pilot scale activated-sludge treatment plant and (2) Reduction in energy consumption by 25% while still maintaining much improved effluent quality. The use of flow and load forecasting allowed reduction in the volume of storage needed to achieve load smoothing and ARIMA-type models were found suitable for flow and load forecasting. (Sand-PTT)
W90-02062

APPLICATION OF ICA IN SEWAGE TREATMENT: WITNEY EVALUATION AND DEMONSTRATION FACILITY (EDF).
Water Research Centre, Stevenage (England).
A. J. Butwell, J. M. Burns, R. S. Fielden, and M. J. Berry.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1239-1248, 1989. 4 fig, 1 tab, 10 ref.

Descriptors: *Instrumentation, *Wastewater treatment, *Control systems, *Automation, England, Management systems, Monitoring, Computers, Operating costs.

The Witney Sewage Treatment Works of Thames Water has been established as the Evaluation and Demonstration Facility (EDF) for instrumentation, control and automation in sewage treatment. The objectives of the process related EDF program have included demonstration of the viability of computer-based process management systems, the investigation of the interactions of processes and the development of methods for their optimization. Evaluation of the process monitoring instrumentation has demonstrated that while severe shortcomings still exist in some areas reliable process automation can be achieved. Successful routine operation of the Whitney plant has been maintained by the automatic control system and a detailed assessment of the main control functions has shown benefits which include cost savings, more accurate control and early warning of equipment failure. Progress has also been made in the modelling both of process performance and of operating costs. This work will lead to the development of software tools to aid process management and to enable process optimization. (Author's abstract)
W90-02063

COMPARISON OF SEVERAL CONTROL ALGORITHMS FOR ACTIVATED SLUDGE WASTE RATE.
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil and Ocean Engineering.
D. A. Vaccari, and C. Christodoulatos.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1249-1260, 1989. 3 fig, 1 tab, 14 ref.

Descriptors: *Activated sludge process, *Wastewater treatment, *Biological wastewater treatment, *Control systems, Algorithms, Biochemical oxygen demand, Simulation analysis, Computer models.

Several algorithms for the control of the waste flow rate of the activated sludge process were compared by computer simulation. The algorithms included: constant waste flow rate; constant proportion of the mass; proportional-integral-derivative (PID) control of the dynamic sludge age (DSA); PID control of mass inventory; and feedforward ratio control based on BOD loading. The study examined the effect of each algorithm on variability in DSA, biomass, and the food-to-microorganism (F/M) ratio. PID control of DSA minimized variability in sludge age; PID control of biomass minimized variability in biomass; and constant flow rate minimized variability in F/M ratio when mixed liquor was wasted; when return sludge was wasted then constant proportion wasting was significantly better than constant flow wasting in terms of sludge age variability. Until the relationship between sludge age, F/M and biomass and effluent quality in an unsteady-state process is better understood, a conservative control strategy is recommended: plants that waste mixed liquor should use constant flow wasting; those that waste return sludge should use constant proportion wasting. (Author's abstract)
W90-02064

AUTOMATION OF BATCH WASTEWATER TREATMENT SYSTEMS USING PROGRAMMABLE LOGIC CONTROLLERS.
Purdue Univ., Lafayette, IN. School of Civil Engineering.
J. E. Alleman, M. W. Sweeny, and D. M. Kamber.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1271-1282, 1989. 5 fig, 26 ref.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Automation, *Control systems, Batch reactors, Disinfection, Filtration, Monitoring, Computers.

Total automated process control of a full-scale wastewater treatment facility was successfully achieved using a programmable logic controller. This facility includes 3 sequencing batch reactors, 3 downflow pressure filters, and 2 ultraviolet disinfection units. The control system routinely manipulates 68 equipment items within the plant, as well as continuously monitoring the operational status of all such equipment. The controller also handles emergency startup/shutdown conditions, cycling of redundant equipment items, and equipment failure situations. In addition, telephone-modem communications with the controller can be obtained to facilitate remote system evaluation and troubleshooting. National recognition of the engineering design excellence and innovation applied to this unique automated facility was recently awarded by the American Consulting Engineers Council, with its designation of this plant as one of the top 10 engineering projects within the U.S. for 1986. (Author's abstract)
W90-02066

OXYGEN TRANSFER EFFICIENCY MEASUREMENTS USING OFF-GAS TECHNIQUES.
Wisconsin Univ., Madison. Dept. of Civil Engineering.
W. C. Boyle, B. G. Hellstrom, and L. Ewing.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1295-1300, 1989. 1 fig, 13 ref.

Descriptors: *Off-gas technique, *Wastewater treatment, *Oxygen transfer, *Biological wastewater treatment, *Aeration, Oxygen uptake, Aeration tanks.

The off-gas technique for measuring oxygen transfer efficiency (OTE) in aeration tanks under process conditions was proposed as an accurate technique for calibrating or verifying on-line methods used to estimate oxygen uptake rates (OUR). The theoretical development and application of the off-gas technique in verifying or calibrating existing on-line methods for estimating OUR is presented. The potential advantages of off-gas as an on-line OUR device include: simple and straightforward method to estimate OUR; high level of precision ion estimating OTE; accuracy to estimate OTE is excellent; can be used under a variety of process mixing conditions ranging from completely mixed to plug flow; less sensitive to dissolved oxygen measurement errors; and provides useful information on spatial and temporal changes in alpha, diffuser efficiency, and OUR. (Sand-PTT)
W90-02068

INSTRUMENT TRIPLICATION IN SEWAGE TREATMENT.
Water Research Centre, Stevenage (England).
J. M. Burns.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1301-1308, 1989. 2 fig, 3 ref.

Descriptors: *Wastewater treatment, *Automation, *Instrumentation, *Monitoring, Data acquisition, Quality control.

One of the main problems with the introduction of automation is the poor performance of some instrumentation. One possible way of improving this situation is through triplication of the instruments, i.e., the use of triple active redundancy. This approach should give improvements in data availability, accuracy and help identify instrument faults. Reliability theory may be used to show that gains in availability of up to 10% are possible, but if the basic instrument availability is less than 50%, then triplication will actually decrease the overall availability. The dissolved oxygen instruments at Witney STW (Thames Water) have been triplicated. Individual instruments were found to have an availability of 90%, giving a theoretical triple availability of 97%. The overall availability measured was only 92%, mainly because the failures were not always random and independent. Uncertainty in the data was reduced by 40% because of the effect of averaging, but drift detection was not

as successful as hoped due to the presence of significant short-term jitter in the dissolved oxygen readings. The cost of triplication can be significant in both extra hardware and extra maintenance. (Author's abstract)
W90-02069

CONTROL OF POLYMER ADDITION FOR SLUDGE CONDITIONING: A DEMONSTRATION STUDY.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
H. W. Campbell, and P. J. Crescuolo.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1309-1317, 1989. 15 fig, 5 ref.

Descriptors: *Wastewater treatment, *Sludge, *Automation, *Control systems, *Sludge conditioning, Sludge drying, Sludge thickening, Dewatering, Anaerobic digestion, Economic aspects.

The need for automatic control of sludge conditioning systems resulted in the development of the sludge conditioning controller (SCC). The SCC consists of two major subsystems: the sampling system and the central control panel. One sampling vessel is required for each independent polymer dosing unit while the central control panel is configured to handle up to four sampling systems. The final phase of the program involved demonstrating the operation of the SCC at a full-scale dewatering plant. The SCC was installed on a two-meter belt press, dewatering anaerobically digested sludge. The evaluation was conducted by comparing the results of historical manual operation with those achieved on the same press under automatic SCC control. Analysis of the data indicated: (1) The sludge conditioning controller can operate without plugging or fouling over an extended period of time. During the entire study, a period of almost seven months, the sensor and sampling vessel were only cleaned manually two times. (2) Operation of the SCC results in a polymer flowrate-versus-time relationship which is distinctly different from that observed during manual operation without extensive instrumentation and data-logging capabilities. (3) The average potential savings with the SCC is estimated to be 24%, as compared to historical data. Similar polymer savings can theoretically be achieved by a skilled operator who has a highly instrumented system complete with a data The disadvantage with this approach is that the majority of the operators' time will be spent making adjustments to the system and the cost of an instrumentation package comparable to that used in this study is considerably more than the cost of an SCC. Visual observation of the press throughout the study indicated that solids recovery was improved during periods when the SCC was operational. (Sand-PTT)
W90-02070

AUTOMATION AND OPTIMIZATION OF CENTRIFUGE SLUDGE DEWATERING.
Bonnier Technology Group, Lausanne (Switzerland).
G. Schrank, and C. Murren.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1319-1324, 1989. 4 fig, 3 ref.

Descriptors: *Wastewater treatment, *Automation, *Sludge drying, *Dewatering, Sludge cake, Centrifugation, Control systems, Monitoring, Turbidity.

The dehydration of sewage treatment plant sludges has become one of the major problems in the treatment of waste water. Very high costs, especially those of flocculation additives, increasingly call for optimization of this phase of the process. Taking the dewatering of sludge by centrifugation as an example, two different approaches can be considered: mechanical excess sludge thickening without the use of additives and the dehydration of sewage sludge with use of chemical additives. The performance of chamber and belt presses, of clarifiers and aeration basins, of thickeners or flotation and sedimentation plants can be improved by means of an optimising controller. A prerequisite of any automation is the reliable acquisition of data of the parameters required for control. Continuous measurement of the concentration of suspended solids in the sludge that is to be dewatered, of sludge flow and of the turbidity of the clear phase (centrate) leaving the centrifuge, make it possible to design several methods of effective control. (Author's abstract)
W90-02071

MEASUREMENTS, DATA ANALYSIS AND CONTROL METHODS IN WASTEWATER TREATMENT PLANTS: STATE OF THE ART AND FUTURE TRENDS.
Lund Univ. (Sweden). Dept. of Industrial Automation.
G. Olsson, B. Andersson, B. G. Hellstrom, H. Holstrom, and L. G. Reinius.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1333-1345, 1989. 6 fig, 24 ref.

Descriptors: *Instrumentation, *Wastewater treatment, *Control systems, *Data processing, Computers, Sweden, Instrumentation.

The fact that any wastewater treatment plant is highly dynamic has to be reflected both in measurements and in control. This report, a summary of a committee for the Swedish Water and Wastewater Works Association, discusses relevant sampling times for different measurements both from the inherent dynamics and from the variability of the disturbances. In order to obtain relevant data analysis the purpose of the measurements has to be clearly stated. Interesting and relevant measurement variables are listed and a short survey of existing instrumentation is presented. The transfer of data from the primary sensor to the computer has to be carefully designed. The different compromises between computer storage capacity, data formats and other relevant information are discussed. Some methods of parameter estimation and model building from measurement data are discussed, particularly with the purpose of making the methods available for on-line use. It is shown how estimated models can be used for the operation of plants. Different control methods are discussed, with emphasis on plant quality control, like dissolved oxygen, return sludge and waste sludge control. Dynamic models offer interesting possibilities for plant simulation, and simulators are being developed that can support the operator with further predictive information. Some future knowledge-based systems for process diagnosis offer new possibilities to use natural language for systematic error analysis and diagnostic searches. (Author's abstract)
W90-02073

SLUDGE REAERATION IN TWO-STEP NITRIFICATION.
District of Columbia Dept. of Environmental Services, Washington. Water and Sewage Utility Administration.
W. Bailey, W. White, C. Wilber, T. E. Wilson, and R. Bizzarri.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1347-1358, 1989. 9 fig, 2 tab, 13 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Aeration, *Nitrification, Activated sludge process, Nitrogen removal, District of Columbia, Step-feed design, Sludge digestion.

The District of Columbia has developed a unique way to overcome site limitations, reduce tankage requirements and at the same time add flexibility to its Blue Plains Wastewater Treatment Plant. This 13.6 cu m/s (309 MGD) two-stage nitrification plant will be expanded to 16.3 cu m/s (370 MGD) by using step feed in both steps. Providing step-feed capability is already well known to be an effective method for reducing tankage and providing operating flexibility for secondary (carbonaceous) systems. Using it in a nitrifying system is believed to be unique, however. The Blue Plains Step Feed upgrades involve full step feed in the carbonaceous step and limited step feed (re-aeration) in the second step. Results show that tanking can be cut by one-third over conventional single sludge technology by using a two-stage step-feed technology. Additionally, effluent quality will remain at least as good--probably better--and reliability and flexibility have been increased by the provision of two-stage step-feed capability. (Sand-PTT)
W90-02074

OPERATION OF THE SOREQ WASTEWATER TREATMENT PLANT WITH A SINGLE-STAGE NITRIFICATION-DENITRIFICATION ACTIVATED SLUDGE SYSTEM.
Tahal Consulting Engineers Ltd., Tel-Aviv (Israel).
G. Arueste, D. Farchill, M. Goldstein, and Y. Gruber.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1359-1372, 1989. 7 fig, 2 tab, 6 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge process, *Nitrification, *Denitrification, Nitrogen removal, Sludge digestion, Israel.

The Soreq Biological Wastewater Treatment Plant in Israel has been in operation almost 1 1/2 years. The treatment performance and operational data obtained during the first year of full-scale operation, following the running-in period, are detailed as four consecutive seasonal operating periods. The results achieved have demonstrated the efficiency, in carbonaceous matter removal and the nitrification-denitrification processes, of the single-stage system,operated without primary treatment. A high degree of carbonaceous matter removal was achieved consistently during the entire year of plant operation. Representative average remove efficiencies for total BOD and COD were 96% and 92%, respectively. The denitrification process efficiency was consistently high throughout the year the automatic control of the number of active rotor-aerators by the continuous respirometer unit has assisted in achieving low nitrate-nitrogen and nitrite-nitrogen effluent concentrations. Two anaerobic contact tanks, preceding the anoxic zone of the biological reactors, were brought into operation at the end of March 1988. A consistent improvement of the sludge settling characteristics was observed for a period of 9 weeks after placing the tanks in operation. An improvement in phosphorus removal efficiency was also observed after the anaerobic tanks were placed in operation. (Sand-PTT)
W90-02075

FULL-SCALE EXPERIENCES WITH BIOLOGICAL PHOSPHORUS REMOVAL AT THE WASTEWATER TREATMENT PLANTS OF WEST BERLIN.
Technische Univ. Braunschweig (Germany, F.R.). Abt. fuer Siedlungswasserwirtschaft.
R. Boll, R. Kayser, A. Peter, and F. Sarfert.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1373-1387, 1989. 8 fig, 7 tab, 10 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Phosphorus removal, Activated sludge process, Bulking sludge, Pilot plants, Berlin, Anaerobic digestion, West Germany.

In investigations concerning sludge debulking in Berlin enhanced biological P removal was first observed unexpectedly. Since 1986 an officially preset limit of 2 mg TP/L must be kept in all Berlin wastewater discharges, it was decided to explore the capabilities of the observed mechanism under the specific circumstances of the existing two large treatment plants in Ruhleben (240,000 cu m/d) and Marienfelde (100,000 cu m/d). For this purpose some of the existing units at both plants were equipped with anaerobic zones which were generated mainly by process modifications. Additionally stage one of the Ruhleben plant was altered completely in order to investigate the combination of biological P and N removal as a special pilot study in three parallel trains. The results indicate that in general the process works more efficiently as the sludge loading rate increases. Especially when nitrification is suppressed, anaerobic contact times of less than one hour seem suffi-

cient to induce the necessary stress conditions upon the activated sludge. In this respect the treatment performance of stage two at the Ruhleben plant is remarkable. Even though the inlet zones were slightly aerated for mixing and in periods of nitrification received nitrate via return sludge, the biological phosphorus removal worked well and was stable. It is stressed that all examinations were performed under full-scale conditions. At present the given limit of 2 mg TP/L in the Ruhleben plant is met without any chemical precipitation, at least on average. From the beginning biological P removal will be integrated into further projected extensions. (Author's abstract)
W90-02076

CRITICAL LOOK INTO THE DEVIATION OF FULL SCALE PERFORMANCE FROM DESIGN EXPECTATIONS.
Environment Canada, Montreal (Quebec). Conservation and Protection.
R. Zaloum.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1389-1402, 1989. 13 fig, 8 tab, 29 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge process, Retention time, Chemical oxygen demand, Suspended solids, Model studies, Design criteria.

Deviations from design expectations in wastewater treatment plants appear to stem from views which assume that a unique response should result from a given set of operating conditions. The results of this study showed that two systems operating at equal organic loads of food to microorganism ratios and at the same SRT (solids retention time) do not necessarily give equal responses. This deviation was linked to the manner in which the HRT and influent COD are manipulated to obtain a constant or uniform load, and to subtle interactions between influent COD, HRT (hydraulic retention time) and SRT on the biomass and effluent responses. Increases of up to 200% in influent COD from one steady level to the next did not significantly influence the effluent VSS (volatile suspended solids) concentration while an effect on filtered COD was observed for increases as low as 20%. Effluent TKN and filtered COD correlated strongly with the operating MLVSS (mixed liquor volatile suspended solids) while phosphorus residual depended on the operating SRT and the organic load removed. These results point to the inadequacy of traditional models to predict effluent quality and point to the need to consider these effects when developing simulation techniques or computer assisted expert systems for the control of waste treatment plants. (Author's abstract)
W90-02077

OPTIMIZATION OF AERATION EFFICIENCY: A DESIGN PROCEDURE FOR SECONDARY TREATMENT USING A HYBRID AERATION SYSTEM.
Water Research Centre, Stevenage (England).
V. K. Thomas, B. Chambers, and W. Dunn.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1403-1419, 1989. 6 fig, 11 tab, 22 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge process, Aeration, Diffused air system, Nitrification, Design, Oxygen transfer, Case studies.

The fine-bubble diffused air (FBDA) system of aeration is most efficiently operated in low rate activated sludge systems. The aeration technique is, however, subject to poor oxygen transfer efficiency and diffuser clogging under increased loading conditions such as are experienced close to the tank inlet in plug-flow systems. Mechanical, surface aeration systems, though apparently less efficient, do not suffer from these disadvantages. The ideal aeration tank configuration for optimum aeration efficiency is therefore: inlet anoxic zone; completely mixed surface aerated zone; plug-flow, fine-bubble diffused air zone with tapered aeration; and clarification tanks. An overall aeration efficiency of 1.5-2.0 kg/kWh is predicted for nitrifying systems, together with an increased diffuser lifetime compared to a conventional FBDA tank. The design procedure is illustrated using parameters for a large UK works. Despite greater civil costs, the reduced running costs and New Present Cost of the hybrid system make it an attractive option when compared to a plug-flow FBDA system or conventional surface aeration plant. (Author's abstract)
W90-02078

EXPERIENCES IN FIELD TESTING A VARIETY OF AERATION EQUIPMENT IN SWEDEN AND IN THE U.S.A. BY OFFGAS ANALYSIS.
Ewing Engineering Co., Milwaukee, WI.
D. T. Redmon, W. C. Boyle, and B. G. Hellstrom.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1421-1429, 1989. 2 fig, 3 tab, 10 ref.

Descriptors: *Wastewater treatment, *Aeration, *Oxygen transfer, Aeration tanks, Off-gas technique, Field tests, Design criteria.

The background and theory of the offgas analysis procedure used in oxygen transfer testing of diffused aeration tanks is reviewed and Correlated with other applicable procedures in parallel tests, and state-of-the-art equipment and accessories. The offgas method has been employed in a number of applications. These can be divided into full-scale testing and pilot-scale testing using columnar tanks of approximately the some water depth as the process tankage. In addition, steady state column tests can be conducted in either clean water or mixed liquor. In full-scale testing to date, the single greatest application has been in the performance testing of a variety of commonly used aeration systems. Side-by-side tests to determine relative performance of two or more systems in the same facility and determination of relative alpha values for different systems has also been a common use of full-scale offgas analysis. Columns employing mixed liquor solids have also been used in situ or external to the aeration facility. The design of these columns to simulate aeration tank conditions is critical if results are to be directly applied to field installations. A relatively recent projected use of the method in Canada and Sweden has been to calibrate and/or verify on-line estimation techniques of oxygen uptake rates for process control. Ewing Engineering Company has developed and made extensive use of the clean water steady state column test to conduct comparative diffuser tests to measure the effects of diffuser fouling and cleaning on oxygen transfer efficiency performance. In Sweden, the Stockholm and Malmo Wastewater Utilities obtained and applied Ewing Engineering Mark V Offgas Analyzers since June 1987. The dominant use has been full-scale performance testing to appraise in-waste oxygen transfer capabilities. In the U.S., a substantial number of full-scale performance tests have been performed using offgas analysis. Accumulation of a large database, made possible by this technique, will be of great benefit to design engineers and operators in the future. (Sand-PTT)
W90-02079

SEWAGE SLUDGE DISPOSAL IN SOUTHERN CALIFORNIA, U.S.A.
QUAD Consultants, Visalia, CA.
For primary bibliographic entry see Field 5E.
W90-02080

RECENT ADVANCES IN MECHANICAL DEWATERING OF DIGESTED SLUDGE.
Metropolitan Water Reclamation District of Greater Chicago, IL. Dept. of Maintenance and Operations.
For primary bibliographic entry see Field 5E.
W90-02081

FULL-SCALE EXPERIENCE WITH SLUDGE TREATMENT AT THE VIENNA SEWAGE WORKS.
Entsorgungsbetriebe Simmering Gesellschaft m.b.H. & K.G., Vienna (Austria).
For primary bibliographic entry see Field 5E.
W90-02082

SYSTEM DESIGN AND FULL-SCALE PLANT STUDY ON A DRYING-INCINERATION SYSTEM FOR SEWAGE SLUDGE.
Kyoto Univ. (Japan). Environment Preservation Center.
For primary bibliographic entry see Field 5E.
W90-02083

CONVERSION OF SLUDGE TO OIL: A NOVEL APPROACH TO SLUDGE MANAGEMENT.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
For primary bibliographic entry see Field 5E.
W90-02084

OPERATIONAL ASPECTS OF DOHA SOUTH SEWAGE TREATMENT WORKS.
Acer John Taylor Ltd., London (England).
P. G. Holmes.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1477-1488, 1989. 2 fig, 4 tab.

Descriptors: *Activated sludge process, *Tertiary wastewater treatment, *Water reuse, *Wastewater treatment, Sludge drying, Dewatering, Operating costs, Doha, Qatar, Nitrification, Irrigation, Wastewater renovation.

Extensions to Doha South Sewage Treatment Works in Qatar provided preliminary, primary, secondary, and tertiary treatment for a design population of 100,000 persons, producing disinfected effluent for use in restricted municipal irrigation with digested sludge being conditioned and dewatered by plate pressing. Secondary treatment was designed to be non-nitrifying surface aeration activated sludge, and experience was gained in preventing partial nitrification by strict control of dissolved oxygen residuals. The works operated successfully to ensure a high quality of final effluent despite hydraulic overloading of 1.85 times design DWF not defined and disruptions caused by contracts to further extend the plant. Treatment costs reflected the emphasis placed upon the purchase of imported chemicals and spare parts to ensure continued operation. Operating experience confirmed the suitability of the chosen processes to achieve intended effluent and sludge qualities. (Author's abstract)
W90-02085

MERSEY BASIN CAMPAIGN: THE TECHNICAL CHALLENGE.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5G.
W90-02086

CSO ABATEMENT FOR THE LOWER CONNECTICUT RIVER IN MASSACHUSETTS.
Metcalf and Eddy, Inc., Wakefield, MA.
J. R. Pearson, P. A. Austin, and D. R. Bingham.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1497-1509, September 1989. 9 fig, 2 tab 11 ref.

Descriptors: *Water pollution control, *Massachusetts, *Combined sewers, *Sewer systems, *Combined sewer overflows, Cost analysis, Model studies, Stormwater management, Controls, Sewer maintenance, Connecticut River.

A major study of the combined sewer overflow (CSO) problem in a portion of the Connecticut River Valley in Massachusetts was conducted. The objective of the study was to develop a cost-effective approach to reduce CSO loadings so that water quality standards and desired river uses are achieved. Significant aspects of the case study include the importance of sewer maintenance, stormwater management modeling methodology, incorporation of use attainability, and the evaluation of various CSO control levels. Sewer inspection and maintenance play a major role in minimizing both dry and wet weather discharges from CSOs.

Sewer system modeling using the SWMM model with a coarse level of system discretization can accurately simulate CSO flows and loads for large drainage areas. A use attainability analysis is necessary to effectively determine that the desired uses of the receiving water are reflected by the designated water quality standard for that water. Complete CSO elimination is not required to meet the designated water quality standards for the study area rivers; however, significant expenditures are required to achieve consistency with state Class B standards, even with the incorporation of a draft CSO abatement policy. Correction of the CSO pollution problem will be a major financial undertaking in many communities. (Author's abstract)
W90-02101

EFFECTS OF SLUDGE AGE AND SELECTOR CONFIGURATION ON THE CONTROL OF FILAMENTOUS BULKING IN THE ACTIVATED SLUDGE PROCESS.
Texas Univ. at Austin.
M. F. Salameh, and J. F. Malina.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1510-1522, September 1989. 17 fig, 2 tab, 20 ref.

Descriptors: *Wastewater treatment, *Activated sludge process, *Bulking sludge, Sludge age, Selector configuration, Sedimentation, Nitrification, Microorganisms, Filamentous organisms.

In bench-scale activated sludge units, four different sludge ages, 10, 6, 4, and 2 days, were evaluated. A supplemented domestic wastewater, drawn after primary sedimentation, was the influent to the reactors that had varying degrees of longitudinal mixing. The diluted sludge volume index was used as the indicator of filamentous bulking. Variables considered were the chemical oxygen demand in the initial compartment of the selector, food to microorganisms ratio in the initial compartment of the selector, (F:Mi), respiration rates in both the selector and the aeration basin, and the specific performance number. The results indicated: (1) The selection process occurs more rapidly and more effectively at lower sludge ages; (2) In general, the lower the dispersion number the lower the average sludge volume index (SVI); (3) The selection process is slow and long operating periods are required to effect complete selection; (4) The conditions in the initial chamber are important. The substrate concentration and the F:Mi should be high (F:Mi > 5 kg COD/kg MLVSS (mixed liquor volatile suspended solids)/d; (5) The system performance number (SPN) has not been well established and has not been applied to operating treatment plants. These experimental results question the applicability of SPN as a single index of sludge settling characteristics; (6) A high biomass concentration should be kept in the selector chambers for better selection. The MLVSS concentration in the initial selector chamber should be three to four times the MLVSS concentration in the main reactor; (7) In general, the higher the average respiration rate the lower the SVI; and (8) Selection is time dependent and increases with time. (Author's abstract)
W90-02102

ADSORPTIVE FILTRATION USING COATED SAND: A NEW APPROACH FOR TREATMENT OF METAL-BEARING WASTES.
Washington Univ., Seattle. Dept. of Environmental Engineering and Science.
M. Edwards, and M. M. Benjamin.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1523-1533, September 1989. 11 fig, 3 tab, 11 ref. E.P.A. R810902-01-2.

Descriptors: *Wastewater treatment, *Filter media, *Metals, *Filtration, Sand, Iron, Hydroxide, Adsorption, Hydrogen ion concentration, Metal-bearing wastes, Head loss.

Sand coated with iron hydroxide was compared with uncoated sand as an adsorbent filter media for treating metal-bearing wastes. The removed metals were recovered and the adsorptive capacity of the media was regenerated by exposure to a pH-3 solution. The oxide coatings were stable when exposed to acidic solutions or moderate abrasion. A column packed with Fe-coated sand successfully treated a synthetic waste containing ammonia complexes of Cd, Zn, and Cu. Nearly complete removals were achieved in treating as many as 40 bed volumes of waste, while no removals occurred in a column packed with sand alone. At low flow rates, particulates were removed sooner on entering a column packed with Fe-coated sand than uncoated sand, contributing to increased head losses by constricting interstitial spaces. Under the conditions studied, the particulate penetration was dependent on influent pH, with lowest penetration and highest head loss at pH 8.5, and highest penetration and lowest head loss at pH 10. Head loss in the column packed with uncoated sand did not depend on pH in the range of 8 to 10. At higher flow rates (3.4 L/sq m/s) with influent at pH 9.3, coated media removed particulates much more efficiently than did uncoated media. In spite of these higher removal efficiencies, observed head losses were comparable for both media types. The oxide-coated sand outperformed uncoated sand in removing particulate metals, as well as both uncomplexed and ammonia-complexed soluble metals. (Author's abstract)
W90-02103

CONSTRUCTING CONTROL CHARTS FOR WASTEWATER TREATMENT PLANT OPERATION.
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
P. M. Berthouex.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1534-1551, September 1989. 11 fig, 3 tab, 29 ref. EPA Agreement CR-812655-01-0.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Control systems, *Control charts, Model studies, Time-series models, Data interpretation.

Most data obtained from wastewater plants do not satisfy the statistical assumptions on which control chart methods are based. A method that extracts more information from the data uses a time-series model. A useful framework for this is the auto regressive integrated (ARIMA) models. The difficulties in implementing this kind of control chart program are identifying an adequate model, estimating the model's parameters, organizing the day-to-day computations, and recognizing when the model becomes inadequate and must be reconstructed and refitted. Control charts can then be used on the residuals from such models. Outliers from the model predictions indicate changes in operating conditions and signal an opportunity for the operator to study and improve the process. The user must be clear about the process-condition that is to be modeled to represent the 'normal' or 'acceptable' operating condition. A record of data representative of this condition must be selected as the basis for setting the control targets, both level and action limits. It may be possible to provide a family of candidate models that could be fitted and checked automatically, using one expert system. If one of the models was found to be adequate, the method of charting with respect to a model could be implemented. (Author's abstract)
W90-02104

DESIGN CONSIDERATIONS FOR FULL-SCALE ANAEROBIC FILTERS.
Arkansas Univ., Fayetteville. Dept. of Civil Engineering.
J. C. Young, and B. S. Yang.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1576-1587, September 1989. 10 fig, 2 tab, 50 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Anaerobic digestion, *Industrial wastes, *Organic wastes, Filtration, Biodegradation, Comparison studies, Surface area, Chemical oxygen demand.

Anaerobic filters represent a developing technology suitable for treatment of industrial wastes containing soluble biodegradable organic materials. A number of full-scale systems have been designed and constructed since 1977, and sufficient data are available to compare field performance to the performance of laboratory-scale units. These comparisons show good agreement between laboratory-scale and full-scale anaerobic filters and show that the most critical design factors affecting performance are hydraulic retention time, media type, and flow direction. Media surface area affects performance slightly, with higher efficiencies associated with higher specific surface areas. However, the difference is so small that the use of media having high specific surface area may not be economically justified. Treatment performance is not affected significantly by influent wastewater having chemical oxygen demand concentrations above about 3,000 mg/L. Reactor height seems to have no significant effect on performance, but minimum media heights of 2 m are recommended. (Author's abstract)
W90-02107

RECOMBINANT DNA IN WASTEWATER: PBR322 DEGRADATION KINETICS.
Dow Chemical Co., Midland, MI.
S. J. Phillips, D. S. Dalgarn, and S. K. Young.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1588-1595, September 1989. 5 fig, 2 tab, 19 ref.

Descriptors: *DNA, *Wastewater treatment, *Biodegradation, Electrophoresis, Trickling filters, Plasmids, Influents, Effluents.

Despite intense interest in recombinant DNA and the environment, no published studies have examined the fate of recombinant DNA in wastewater. In this study the kinetics of breakdown of pBR322 in a two-stage standard rate trickling filter plant were determined. Wastewater samples were taken over a 5-month period from September 1986 to January 1987. Samples were taken from four points within the plant (influent, primary clarifier, final clarifier, and effluent) and mixed with plasmid in vitro. No DNA was released into the environment. Agarose gel electrophoresis was used to determine the conformational state of the plasmid. The results show that covalently closed circular (CCC) plasmid is converted to open circular (OC) or linear form within 10 minutes of contact with untreated influent. The average half-lives for this conversion were influent, 4 minutes; primary, 4 minutes; final, 1 minute; and effluent, 4 minutes. It was concluded that the half-life for unmodified plasmid pBR322 in municipal wastewater is brief. (Author's abstract)
W90-02108

CONTRIBUTION OF METHANOGENESIS TO DENITRIFICATION WITH AN UPFLOW FILTER.
Tokyo Univ. (Japan). Dept. of Urban Engineering.
K. Hanaki, and C. Polprasert.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1604-1611, September 1989. 7 fig, 2 tab 14 ref.

Descriptors: *Wastewater treatment, *Denitrification, *Methanogenesis, *Filters, Hydraulic retention time, Sulfates, Nitrites, Upflow filters, Chemical oxygen demand.

In order to determine the mechanism of simultaneous denitrification and methane production in upflow filters receiving methanol and nitrate, a laboratory-scale upflow filter was fed with synthetic wastewater containing nitrate and methanol to examine the contribution of methanogenesis to denitrification. Complete (99.8%) nitrate removal occurred at a methanol:NO3-N (M:N) ratio > or = 2.30 and at a hydraulic retention time (HRT) longer than 1.5 hours. The surplus methanol after the denitrification was converted to methane with low effluent chemical oxygen demand (COD) at M:N > or = 2.65. Effluent nitrate level depended on HRT; effluent COD depended on influent methanol. Material balance revealed that 75% of methanol involved in denitrification was oxidized by nitrate or nitrite and the methane conversion fraction from methanol was 56%. Sulfate reduction might contribute to methanol degradation. The

filter held biomass well and no biomass leakage was observed. The formed granule contained 50% volatile solids. (Author's abstract)
W90-02110

USE OF PEAT IN THE TREATMENT OF OILY WATERS.
Regina Univ. (Saskatchewan). Faculty of Engineering.
G. N. Mathavan, and T. Viraraghavan.
Water, Air and Soil Pollution WAPLAC, Vol 45, No. 1-2, p 17-26, May 1989. 2 fig, 7 tab, 22 ref.

Descriptors: *Wastewater treatment, *Peat, *Oil wastes, *Oil pollution, *Oil-water interfaces, Cleanup operations, Isotherms, Adsorption, Mathematical analysis.

Peat is an effective medium in the treatment of oil-in-water emulsions due to its known capacity to absorb oil and its abundant availability. Horticultural Sphagnum peat was used to assess its potential for removal of oil from oily wastewaters. Oily wastewater samples included a low viscosity (50 cP) crude oil Midale, a medium viscosity (130 cP) standard mineral oil, a refinery effluent and a cutting oil emulsion. It was found that the oil binding capacity of the peat was 7.5 to 7.7 times its air dry weight. The percentage removal of oil from oil-in-water emulsions ranged from 21 to 98% depending upon the type of emulsion studied. Batch kinetic studies showed that equilibrium was reached in 1 to 3 hr for the emulsions investigated. Isotherm analysis of the data showed that the Brunauer, Emmett, Teller (BET) isotherm fits the adsorption pattern, generally. By applying the BET isotherm to the particular oil-in-water emulsion, it is possible to calculate the amount of peat required to reduce the oil in the oily water to a desired concentration; a batch adsorption system can be designed to operate on a fill-and-draw basis. (Author's abstract)
W90-02156

PARTICLE SIZE FRACTIONATION AND METAL DISTRIBUTION IN SEWAGE SLUDGES.
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
S. Yeoman, R. M. Sterritt, T. Rudd, and J. N. Lester.
Water, Air and Soil Pollution WAPLAC, Vol. 45, No. 1-2, p 27-42, May 1989. 11 fig, 3 tab, 18 ref.

Descriptors: *Wastewater treatment, *Sludge, *Metal complexes, *Filtration, Particle size, Step filtration, Cadmium, Copper, Nickel, Lead, Zinc, Activated sludge process, Digested sludge, Raw sludge.

A sequential step filtration technique has been used to investigate the different particle size fractions of suspended solids in several raw, activated and digested sewage sludge samples. Liquid sludge was passed through filters with progressively smaller pore sizes, from 100 micrometers down to 0.2 micrometers. The concentrations of Cd, Cu, Ni, Pb, and Zn associated with each particle size fraction were also determined. The particle size distributions indicated that there was a greater proportion of larger particles in the raw and activated sludges than in the digested sludges. Generally in activated sludge the metals tended to be associated with the large particles of >100 micrometers, whereas in raw and digested sludges the metals were found in the smaller particle size fractions from 20 micrometers down to 2.5 micrometers. Calculating specific associations in terms of mg/kg the 8 to 20 micrometer range appears important in complexing metals. This was especially evident when comparing the sludges from the same treatment works. Generally distributions were more widespread when results were expressed as mg/kg as opposed to mg/L. (Author's abstract)
W90-02157

SELENATE REDUCTION TO ELEMENTAL SELENIUM BY ANAEROBIC BACTERIA IN SEDIMENTS AND CULTURE: BIOGEOCHEMICAL SIGNIFICANCE OF A NOVEL, SULFATE-INDEPENDENT RESPIRATION.
Geological Survey, Menlo Park, CA. Water Resources Div.
For primary bibliographic entry see Field 2K.
W90-02168

SORPTION OF TOXIC ORGANIC COMPOUNDS ON WASTEWATER SOLIDS: CORRELATION WITH FUNDAMENTAL PROPERTIES.
Environmental Protection Agency, Cincinnati, OH.
R. A. Dobbs, L. Wang, and R. Govind.
Environmental Science and Technology ESTHAG, Vol. 23, No. 9, p 1092-1097, September 1989. 3 fig, 9 tab, 31 ref. EPA Cooperative Agreement No. CR81293-010.

Descriptors: *Wastewater treatment, *Municipal wastewater, *Biological wastewater treatment, *Sorption, Octanol-water partition coefficient.

Sorption of toxic organic compounds on primary, mixed-liquor, and digested solids from municipal wastewater treatment plants has been correlated with octanol-water partition coefficients and with modified Randic indexes. It has been shown that the correlations are the same for all three types of wastewater solids used in this study if partition coefficients are calculated on the basis of organic content of the solids. The correlations developed are useful for assessing the role of sorption in the treatment of toxic or hazardous compounds in conventional biological wastewater treatment plants. Correlations developed provide a basis for predicting the concentration of toxic compounds associated with wastewater solids at a given equilibrium concentration in the aqueous phase. Organic compounds in sludge can impact anaerobic digestion, land spreading, incineration, and ocean dumping of sludges. Estimates of the concentration of toxic compounds in sludge allow assessment of the impact of toxic compounds on sludge disposal options. (Author's abstract)
W90-02243

LEACHING FROM SOLIDIFIED WASTE FORMS UNDER SATURATED AND UNSATURATED CONDITIONS.
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Lab.
S. B. Oblath.
Environmental Science and Technology ESTHAG, Vol. 23, No. 9, p 1098-1102, September 1989. 4 fig, 1 tab, 20 ref. DOE Contract No. DE-AC09-76SR00001.

Descriptors: *Nitrates, *Portland cements, *Radioactive wastes, *Leachates, Water pollution sources, Lysimeters.

The leaching behavior of nitrate ion from a cement-based waste form containing low-level radioactive waste was shown to be identical under saturated and unsaturated soil conditions. Only in soils containing less than 2% of their weight in water did the leach rate decrease. The observation of identical leach rates under saturated and unsaturated conditions is explained by diffusion through the waste form being the limiting step. Diffusion through the soil decreases in very dry soil and the limiting step changes. These laboratory tests were verified by measurements on a similar, Portland cement-based waste from in a field lysimeter. (Author's abstract)
W90-02244

DETERMINATION AND REDUCTION OF PHYTOTOXICITY OF TWO INDUSTRIAL WASTE EFFLUENTS.
Illinois State Water Survey, Peoria. Water Quality Section.
For primary bibliographic entry see Field 5C.
W90-02265

CAPACITY OF THE ACTIVATION PROCESS IN CASCADE CIRCUITS (LEISTUNGSFAEHIGKEIT VON BELEBUNGSVERFAHREN IN KASKADENSCHALTUNG).
Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Wasserwessen.
H. Hoffmann.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-81653. Price codes: E15 in paper copy, A01 in microfiche. 1987. 207p, 103 fig, 64 tab, 72 ref. English summary.

Descriptors: *Sanitary engineering, *Wastewater treatment, *Activated sludge process, *Aeration, Cascade operation, Design criteria, Sludge volume index, Drainage, Stability, Lime.

Various experimental settings were compared to determine which method of cascade plant operation has advantages when compared with fully mixed plants in sewage facilities. The effect of the method of operation on the increase in capacity, reduction of the sludge volume index, improvement of drainage, elimination of nutrients and process stability are all examined. The size and the number of cascade stages were varied and, by establishing anoxic zones, different oxygen concentrations could be produced. In addition, the effect of aerating the returned sludge and dosing with lime in the incoming post-settling pipe was checked. With regard to upgrading overloaded sewage plants, the capacity of cascade plants was examined at a loading between 1.0 and 2.0 kg/cu m/d. From the results of the investigation, proposals were developed for specifying the necessary number of cascades, their equipment and size, the oxygen consumption, the settling capacity and the drainage behavior of the sludge. (Author's abstract)
W90-02268

MICROBIOLOGICAL INVESTIGATIONS OF HETEROTROPHIC NITRIFICATION IN ACTIVATED SLUDGE PLANTS WITH FIXED SLUDGE BEDS (MIKROBIOLOGISCHE UNTERSUCHUNGEN ZUR HETEROTROPHEN NITRIFIKATION IN BELEBTSCHLAMMANLAGEN MIT FESTKOERPEREINBAUTEN).
Institut fuer Umweltanalytik und Biotechnologie G.m.b.H., Pforzheim (Germany, F.R.).
D. Dengler, and H. Eberhardt.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-81680/GAR. Price codes: E09 in paper copy, A01 in microfiche. 1986. 53p, 24 fig, 5 tab, 21 ref. English summary.

Descriptors: *Wastewater treatment, *Activated sludge process, *Municipal wastewater, *Nitrification, Bacteria, Microorganisms, Ammonia, Cultures.

Bacteria which do not merely nitrify ammonium to nitrate or nitrite, but eliminate it from a synthetic medium, were isolated from the Pfinztal, Germany, municipal sewage-treatment plant. From the same facility, enrichment cultures were obtained which exhibit a stable nitrification rate in a medium with sodium acetate as the carbon source. The isolation of heterotrophic or autotrophic nitrifiers was not successful. The enrichment cultures showed a constant nitrification capacity (stoichiometric conversion of a high ammonium concentration to nitrate) in fixed-bed pilot-plant tests. (Shidler-PTT)
W90-02270

HYDROMETALLURGICAL SEPARATION OF HEAVY METALS FROM SLURRIES (HYDROMETALLURGISCHE ABIRENNUNG VON SCHWERMETALLEN AUS SCHLAMMEN).
Technische Univ. Berlin (Germany, F.R.). Fachbereich 17 - Werkstoffwissenschaften.
H. Rossel.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-770254/GAR. Price codes: A08 in paper copy, A01 in microfiche. NP-8770254, January 1987. 151p, 37 fig, 19 tab, 79 ref. English summary.

Descriptors: *Municipal wastes, *Heavy metals, *Sludge utilization, *Wastewater treatment, *Waste treatment, Separation techniques, Lead, Cadmium, Copper, Chromium, Nickel, Zinc, Fer-

tilizer, Acid extraction, Leaching, Ferric Chloride, Sulfide precipitation, Costs.

The extraction of lead, cadmium, copper, chromium, nickel, and zinc from municipal sewage sludge and excavated earth was investigated in order to find out whether the heavy metal concentrations can be reduced to a level where the sludges can be used as agricultural fertilizers. It was found that nonferrous metals can be mobilized by acid oxidizing leaching and separated by a solid/liquid separation process. The most efficient oxidant is ferric chloride which can be regenerated by reoxidation and thus enables circulation of the alkaline solution. This will lower the cost of the process. The dissolved nonferrous metals can be separated by a sulfide precipitation process. Four different process variants were compared with regard to their cost. (Author's abstract)
W90-02280

TESTS OF MEASURES FOR THE IMPROVEMENT OF THE CAPACITY OF SMALL SEWAGE TREATMENT PLANTS (ERPROBUNG VON MASSNAHMEN ZUR VERBESSERUNG DER LEISTUNG KLEINERER KLAERANIAGEN).
Institut fuer Umweltanalytik und Biotechnologie G.m.b.H., Pforzheim (Germany, F.R.).
H. Eberhardt, and A. Baum.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/A88-80298/GAR. Price codes: E07 in paper copy. 1987. 138 p, 71 tab, 2 fig, 13 ref. English summary.

Descriptors: *Wastewater treatment facilities, *Quality control, *Systems analysis, *Operating policies, *Personnel management, Training, Planning, Operating manuals.

The necessary organizational analysis, the means and quantity of operational data recording, and the level of training of the personnel are generally insufficient at small treatment plants. Their efficiency can often be improved by intermediate and advanced staff training; external technical support, advice, and supervision; better data acquisition in the various process steps; and improvement of control engineering. Improved direction and supervision of planning, training, preparation of operating manuals, and technical support are also required. (Author's abstract)
W90-02285

INTERFERENCE WITH THE FUNCTIONAL EFFICIENCY OF BIOLOGICAL SEWAGE TREATMENT PLANTS BY MICROBICIDAL SUBSTANCES (BEEINTRAECHTIGUNG DER FUNKTIONSTUECHTIGKEIT BIOLOGISCHER KLAERANLAGEN AM BEISPIEL MIKROBIZIDER STOFFE).
Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Karlsruhe (Germany, F.R.). Inst. fuer Systemtechnik und Innovationsforschung.
P. Kunz, and G. Frietsch.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/A88-80498/GAR. Price codes: E07 in paper copy. January 1985. 292 p, 41 tab, 51 fig, 360 ref. English summary.

Descriptors: *Bactericides, *Biological wastewater treatment, *Wastewater treatment, *Microorganisms, Toxicity, Disinfectants, Preservatives.

Due to their use as disinfectants and preservatives, microbicidal substances are important in the health field and in preservation and production processes. However, these substances can also present problems because they are potentially damaging to the microorganisms in sewage treatment plants or can have a biocidal effect on natural waters. The introduction of microbicides into various areas, their application, and their effects and significance with respect to the functional efficiency of sewage treatment plants was studied. With the aid of case-studies (and based on biological principles, previous investigations of process stability, and cases of damage to sewage treatment plants), the potential effect of microbicidal substances in a cause-and-effect model of a treatment plant ecosystem is shown in terms of which microbial associations and which plant types are affected the earliest. (Author's abstract)
W90-02286

SUPERFUND RECORD OF DECISION: FRONTIER HARD CHROME, WA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
For primary bibliographic entry see Field 5G.
W90-02289

DURABILITY OF BITUMINOUS-LINED CORRUGATED STEEL PIPE STORM SEWERS (APPENDICES).
Pirnie (Malcolm), Inc., Columbus, OH.
S. Zeid, and M. Macy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-121347. Price codes: A14 in paper copy, A01 in microfiche. Report No. FHWA/OH-85/015, April 1985. 362p, 5 append. State Job No. 14367(0).

Descriptors: *Pipes, *Storm sewers, *Lining, Ohio, Performance evaluation, Pipelines, Field tests.

In 1983, the Ohio Department of Transportation (ODOT) initiated a study to determine the durability of bituminous lined corruaged steel pipe storm sewers at various sites in Ohio. The study involved field inspection and analysis of representative bituminous lined storm sewers throughout Ohio. This volume contains the appendices to the final report on the site. The appendices are as follows: (A) site investigation locations; (B) data listing-problem pipe sections; (C) pipe section summary; (D) field data sheets; and (E) listing-deflection and alignment problems. (Lantz-PTT)
W90-02299

TECHNOLOGY ASSESSMENT OF WASTEWATER TREATMENT ALTERNATIVES FOR COMPLIANCE WITH DEOXYGENATING WASTES EFFLUENT STANDARDS.
Institute of Technology Assessment, Springfield, IL.
S. F. John, and L. W. Skelton.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-122279. Price codes: A06 in paper copy, A01 in microfiche. Report No. ILENR/RE-EA-88/18, September 1988. 140p, 10 fig, 8 tab, 51 ref, append. Illinois Department of Energy and Natural Resources Contract EA 44, Project 87/7012.

Descriptors: *Wastewater treatment, *Effluent limitations, *Water quality standards, *Illinois, *Wastewater lagoons, Standards, Performance evaluation, Economic aspects, Land disposal, Lagoons.

The Illinois Environmental Protection Agency (IEPA) has proposed amendments to the lagoon exemption provisions of 35 Ill. Admin. Code 304.120 applicable to the 5-day biochemical oxygen demand (BOD5) and total suspended solids effluent limitations for discharge to waters of the State. The proposal, designated R86-17, if accepted by the Pollution Control Board in its present form, would retain existing lagoon exemption language and expand the number of sources eligible to receive exemptions. Two key features of both the existing and proposed lagoon exemption rules are that they: provide more relaxed effluent standards for sources employing one particular treatment technology, third-stage treatment lagoons, than for sources using any other treatment technology; and restrict eligibility for the relaxed effluent standards to sources with waste loads below a specific population equivalent (PE). The proposal would increase the maximum PE from 2500 to 5000. Only publicly owned treatment works in the 2500 to 5000 range would be eligible for the lagoon exemption while both public and private treatment works under 2500 PE are eligible. At the request of the Illinois Department of Energy and Natural Resources, this report presents information on technologies, particularly land treatment technologies, which may provide alternative options for many of the communities affected by this proposed rule change. Chapter 2 of the report examines some of the more prevalent misconceptions about land treatment as well as some of the issues implied in the proposed rule change. In Chapter 3, a range of wastewater treatment technologies available to Illinois communities is described and their expected performances compared. Attention is given to lagoons, because they are the subject of the proposal and to alternative technologies. Chapters 4 and 5 discuss, primarily in qualitative terms, the costs and benefits of wastewater treatment technologies and Chapter 6 identifies and evaluates some of the economic impacts of these technologies. (Lantz-PTT)
W90-02304

TRICKLING FILTER/SOLIDS CONTACT PROCESS: APPLICATION TO ARMY WASTEWATER PLANTS.
Construction Engineering Research Lab. (Army), Champaign, IL.
R. I. Scholze.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A199 858. Price codes: A04 in paper copy, A01 in microfiche. USA-CERL Technical Report N-88/14, August 1988. 51p, 6 fig, 9 tab, 22 ref, 2 append.

Descriptors: *Military reservations, *Wastewater treatment, *Trickling filters, *Contact filters, *Secondary wastewater treatment, Economic aspects, Biochemical oxygen demand, Suspended sediments, Costs, Sludge cake, Economic aspects.

More than half of the Army's wastewater treatment plants use trickling filter technology to provide secondary treatment. With the growth in regional population at many installations, there is concern that trickling filters alone may not be able to handle the additiona loads generated. Several add-on and replacement techniques recently have emerged for trickling filter systems. These methods have reinforced the role of trickling filters in providing effective, economical secondary treatment. Of particular interest to the Army is the trickling filter/solids contact (TS/SC) process. Based on a literature review, site visits, and telephone surveys, TF/SC can produce high-quality effluent and is simple to operate, reliable, and cost-effective. The process has several advantages over competing methods including: (1) monthly average biochemical oxygen demand (BOD) and suspended solids (SS) of 10 mg/L or less are attainable without effluent filtration; (2) soluble BOD reduction in the solids channel, beyond that normally expected from the trickling filters, provides a cost-effective method of producing an effluent meeting requirements; (3) waste biological sludge from the TF/SC process is dense enough for efficient wasting directly to the primary clarifiers for cosettling with the primary sludge; (4) sludge yields in the TF/SC process are comparable to those of competing technologies so that associated sludge handling and treatment costs are comparable; (5) TF/SC technology is stable and relatively simple, requiring much less equipment, electrical control, and operator attention than other technologies, resulting in substantially lower total operation and maintenance costs and (6) TF/SC consumes lless than half the estimated annual energy demand of conventional technology because of its lower overall horsepower requirements. Reduced sludge recycle compared to the activated sludge process is significant. (Lantz-PTT)
W90-02308

COMPARISON OF OXYGEN TRANSFER TEST METHODS IN A TOTAL BARRIER OXIDATION DITCH CONFIGURATION.
BCM Converse, Inc., Mobile, AL.
R. C. Borneman.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-103931. Price codes: A18 in paper copy, A01 in microfiche. Report No. EPA/600/2-88/059, October 1988. 395p, 9 fig, 17 tab, 11 ref, 10 append. EPA Contract CR813448.

Descriptors: *Oxidation ditches, *Wastewater treatment, *Oxidation, *Oxygen transfer, *Aeration, Ditches, Aerated lagoons, Alabama, Virginia, Water pollution treatment, Chemical treatment.

The Total Barrier Oxidation Ditch (TBOD) is a recent development in oxidation ditch wastewater treatment technology. It differs from conventional oxidation ditch configurations in that a vertical wall is installed across the entire cross-section of the ditch channel. Circulating flow is thereby intercepted at each pass and forced through one or more draft tube submerged turbine aerators (DTSTA's) located on the upstream side of the wall. Aerated wastewater is returned to the channel downstream of the wall through one or more J-tubes that pass under the wall. This project was carried out in 1986 and 1987 for the dual purpose of: (1) evaluating the applicability of selected test procedures developed by the American Society of Civil Engineers (ASCE) Committee on Oxygen Transfer for estimating the oxygen transfer performance of a circulating oval aeration basin as represented by the TBOD configuration; and (2) generating reliable and clean process water oxygen transfer data on two TBOD's at Opelika, Alabama, and South Hill, Virginia. The methods used in the clean water test program included the ASCE nonsteady state procedure, the krypton/tritium radiotracer procedure, and a technique in which a dissolved oxygen mass balance is performed across the aeration device. In the process water test program, methods utililized included off-gas analysis and the above radiotracer procedure at both sites plus a process oxygen consumption/oxygen supply mass balance at one of the sites. (Author's abstract)
W90-02312

SOIL CHEMISTRY AND PHOSPHORUS RETENTION CAPACITY OF NORTH CAROLINA COASTAL PLAIN SWAMPS RECEIVING SEWAGE EFFLUENT.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
C. J. Richardson, M. R. Walbridge, and A. Burns.
Water Resources Research Institute of The University of North Carolina Report No. 241, November 1988. 96p, 7 fig, 11 tab, 72 ref, 2 append. WRRI Project 70063.

Descriptors: *Wastewater treatment, *Tertiary wastewater treatment, *Wetlands, *Soil chemistry, *Phosphorus, *Coastal marshes, *Wastewater disposal, *Swamps, Coastal plains, Hydrogen ion concentration, Phosphates, Nutrients, Brown Marsh Swamp, Cashie Swamp, Wahtom Swamp, Soil amendments.

The soil chemical properties and P sorption potentials of three North Carolina coastal plain swamps were analyzed for: (1) characterization of their soil chemistries; (2) both short-term and long-term effects of wastewater addition on soil chemistry; (3) determination of their P sorption capacities and the relationships between P sorption and soil chemistry; and (4) development of a predictive index to evaluate the P sorption potentials of other coastal plain swamps. At Brown Marsh Swamp, soils were analyzed both before and after the initiation of wastewater discharge. At Cashie Swamp, which has been receiving wastewater additions for approximately 30 years, soils were collected both above and below the discharge point. Soils from nearby non-impacted Wahtom Swamp were analyzed for comparison. Wastewater additions at Brown Marsh Swamp resulted in significant increases in soil pH, available PO4-P, extractable NH4-N, and total P, and significant decreases in microbial biomass PO4-P and extractable NO3-N. At Cashie Swamp, soils collected below the discharge point had significantly higher concentrations of extractable P, and significantly lower percent organic matter and concentrations of extractable Ca, Mg, and K, total N, total P, and N:P ratios than soils collected above the discharge point. It is estimated that the Clarkton Wastewater treatment plant discharges 221 kg of PO4-P and 295 kg of total P annually into the 0.2 ha Brown Marsh spray field. Based on a modified Langmuir equation estimate of maximum P sorption potential, each hectare of Brown Marsh Swamp soil could sorb nearly two years of annual phosphate discharge from the Clarkton plant in the upper 15 cm of the soil alone. These calculations of maximum sorption potential suggest that this swamp could remove current loading rates for hundreds of years if wastewater P was discharged evenly over the entire swamp. Maximum utilization of wetlands for phosphate removal from wastewater with minimum ecosystem impact can only be achieved under conditions which maximize retention time and the effective surface area of the wetland, and minimize the average impact per unit area. This could be achieved by adding acidified wastewater using a well designed diffusion system. (Lantz-PTT)
W90-02314

FORMATION OF HALOGENATED ORGANICS DURING WASTEWATER DISINFECTION.
North Carolina Univ., Chapel Hill. School of Public Health.
P. C. Singer, R. A. Brown, and J. F. Wiseman.
Water Resources Research Institute of the University of North Carolina Report No. 239, November 1988. 135p, 29 fig, 47 tab, 59 ref. WRRI Project 70027.

Descriptors: *Halogenated hydrocarbons, *Organic compounds, *Wastewater treatment, *Water pollution sources, *Chlorination, Disinfection, Trihalomethane, Halides, Chlorine.

Since the deletion of federally-mandated fecal coliform limits from the definition of secondary wastewater treatment in 1976, most states have been reviewing and modifying their requirements concerning wastewater disinfection, particularly with regard to the use of chlorine. The formation of trihalomethanes (THMs) and total organic halides (TOX) was examined during wastewater chlorination at three wastewater treatment plants in the central Piedmont of North Carolina. TOX and THM formation was evaluated in terms of effluent wastewater quality (e.g. residual chemical oxygen demand, total organic carbon and ammonia concentration), chlorine dose, chlorine contacting system, method of chlorine addition, and chlorine-to-ammonia ratio. The results showed that TOX was present in the unchlorinated wastewater and that additional TOX was formed immediately after chlorine. Small to insignificant amounts of THMs were detected. TOX formation did not increase with increasing contact time, due to the rapid depletion of free chlorine and the formation of combined chlorine in the chlorine contact chamber. The amount of TOX formed as a result of wastewater chlorination ranged from about 50 to 150 micrograms/L (ug/L) at the three plants. Mass balance calculations and in-stream measurements demonstrated that TOX behaves conservatively in the respective receiving streams. Laboratory experiments were conducted on unchlorinated secondary effluent in order to investigate the influence of chlorine dose, chlorine contact time, initial mixing intensity, and ammonia concentration on TOX and THM formation to verify and assist in the interpretation of the field results. At chlorine doses similar to those commonly encountered during wastewater chlorination, TOX formed immediately after chlorine addition, but no additional TOX formation was detected with increasing contact time. TOX and THM formation were sensitive to the ammonia concentration when chlorine-ammonia ratios were $>$ 1 mol/mol (beyond the 'hump' of the breakpoint curve), but not when excess ammonia was present. (Lantz-PTT)
W90-02315

MARINE TREATMENT OF SEWAGE AND SLUDGE.
Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1987. Thomas Telford, London. 1988. 296 p.

Descriptors: *Wastewater disposal, *Marine wastewater treatment, *Conferences, *Wastewater treatment, *Ocean dumping, *Sludge disposal, *Coastal waters, Water pollution control, Legislation, Legal aspects, Case studies, Outfall sewers, Marine environment, Economic aspects.

The sea's capacity to absorb waste products is widely used throughout the world. But, if this resource is to remain a healthy and effective method of disposal, it needs to be better understood. These proceedings discuss the numerous technical, political, legal, economic and environmental problems of marine treatment from the British, European, American and Australian perspectives. Discussions focus on five major themes: (1) an overview of the current situation; (2) current practice--treatment disposal and performance, by outfall; (3) current practice--treatment disposal and performance, by vessel; (4) economic considerations; and (5) (See W90-02318 thru W90-02333) (Lantz-PTT)
W90-02317

MARINE TREATMENT, DISPOSAL AND PERFORMANCE OF SEWAGE OUTFALL--UK PRACTICE AND EXPENDITURE.
Wessex Water Authority, Bristol (England). Engineering and Operations.
For primary bibliographic entry see Field 5E.
W90-02324

SEWAGE TREATMENT STRATEGY FOR THE COLWYN AND ABERCONWY AREAS--AN APPRAISAL OF OPTIONS.
Welsh Water Authority, Powys.
C. Pattinson, and R. Jones.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 159-172, 5 fig.

Descriptors: *Wastewater disposal, *Management planning, *Wales, *Outfall, *Wastewater treatment, *Waste management, *Waste disposal, Case studies, Capital costs, Costs, Colwyn, Aberconwy, Model studies, Wastewater outfall, Ocean dumping.

Considerable problems attach to the formulation of capital investment strategies for sewage treatment in coastal areas due to the difficulties involved in obtaining reliable flow information and in accurately estimating the cost of sea outfalls. Difficulties may also occur due to the necessity of incorporating intensive expenditure on outfall contracts within a limited Capital Program. This case study describes how these problems were overcome by developing a set of standard cost models, by carrying out sensitivity analyses and by adopting specific targets for phasing of capital expenditure. The most appropriate option as a capital investment strategy was along sea outfall linked to wastewater flows from several towns. This option allowed for phasing over a number of years and complied with environmental and road construction restraints. (See also W90-02317) (Lantz-PTT)
W90-02327

THANET SEWAGE DISPOSAL INVESTIGATION AND THE COMPARISON OF JOINT AND LOCAL SOLUTIONS.
Southern Water Authority, Worthing (England).
F. N. Midmer, and M. J. Brown.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 173-187, 2 fig, 6 tab, 7 ref, append.

Descriptors: *Wastewater disposal, *Wastewater treatment, *Waste disposal, *Management planning, Isle of Thanet, Great Britain, Ocean dumping, Margate, Ramsgate, Broadstairs, Costs, Economic aspects, Wastewater outfall, Swimming.

The Isle of Thanet is an important holiday area in East Kent with a total summer population of 180,000 in the four seaside towns of Margate, Ramsgate, Broadstairs and Birchington. Sewage is discharged to the sea through short sea outfalls, which cause pollution of the local beaches. The need for improvements, which had been discussed for many years, was finally brought to a head when Margate was designated a bathing water in accordance with EC Directive 76/160/EEC. This paper outlines the options examined, which varied

from a single outfall for all the towns, through separate schemes, to a single treatment works, and the consideration given to the resource benefits of effluent re-use. The actual capital cost of the various options were very similar but the cheapest in terms of net present value (NPV) was the option which provided separate solutions for each town, separate outfalls for the Thanet coastal towns and sewage treatment work (STW) for the inland town of Sandwich. The chosen strategy was separate outfalls at Margate and Broadstairs and an STW at Ramsgate. Sandwich would receive works treatment and there would be further consideration of a combined works at Richborough serving Ramsgate and Sandwich. (See also W90-02317) (Lantz-PTT)
W90-02328

ECONOMIC ASSESSMENT OF INLAND TREATMENT AND MARINE TREATMENT OPTIONS FOR WEYMOUTH AND PORTLAND.
Wessex Water Authority, Bristol (England).
R. Tyler.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 189-201, 4 tab, 4 ref.

Descriptors: *Wastewater disposal, *Economic aspects, *Wastewater treatment, *Ocean dumping, *Waste disposal, Weymouth, Portland (England), Wastewater outfall, Costs, Environmental effects.

Wessex Water Authority has constructed a long sea outfall to provide sewage disposal by marine treatment for Weymouth and Portland. Before construction began an economic evaluation of marine treatment and alternative inland treatment options was carried out. Post construction experience enables previous assumptions to be examined critically. It was found that a properly designed and executed scheme for the disposal of sewage by marine treatment provides an alternative solution to inland treatment methods which can be economically and environmentally superior. This was demonstrated by a regular monitoring program of both beaches and the marine environment adjacent to the diffusers, and the complete absence of smell or noise problems from the headworks. (See also W90-02317) (Lantz-PTT)
W90-02329

SEMINAR ON WASTEWATER TREATMENT IN URBAN AREAS.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-010223. Price codes: A06 in paper copy, A01 in microfiche. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1986, Visby, Sweden. (1987). 159p.

Descriptors: *Urban areas, *Municipal wastewater, *Wastewater treatment, Conferences, Nitrogen, Denitrification, Sewers, Industrial wastewater.

The Wastewater Treatment in Urban Areas seminar was held in Visby, Sweden 7-9 September 1986. The seminar was organized jointly by the National Environmental Protection Board (SNV) and the Swedish Water and Waste Water Works Association (VAV). Some 40 people took part in the seminar and the following countries were represented: Denmark, Finland, the Federal Republic of Germany, the Polish People's Republic, Sweden and the Union of Soviet Socialist Republics. Papers presented fell into the following three aspects of urban wastewater treatment: sewerage systems; discharge of industrial wastewater to municipal sewerage systems; and reduction of nitrogen. (See W90-02413 thru W90-02426) (Lantz-PTT)
W90-02412

SEWERAGE SYSTEMS: OVERFLOW PROBLEMS AND RENOVATION METHODS.
Plancenter Ltd., Finland.
U. Tanttu.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 15-20.

Descriptors: *Sewers, *Maintenance, *Wastewater facilities, *Overflow, *Water pollution sources, Economic aspects, Costs, Pipes, Water transport, Finland.

Total investments in Finland (1984) spent on sewer systems were roughly FIM 590 million. About 14% of this sum (FIM 82 million), was spent on rehabilitation of networks. However, according to some evaluations, the respective amount should be about FIM 500 million for rehabilitation only. Therefore, keeping the performance of sewer networks satisfactory in the future, is a concern. The overflow problem is one of the most serious problems caused by old and improperly working sewer systems. Several other aspects of sewers in poor condition are: excess hydraulic loading of treatment plants; normal maintenance and operation (flushing, opening of clogs) increases and expense; unexpected renovation works and interruptions in operation that cause trouble in traffic, odor problems in the environment, and hygienic hazards; and the performance of other underground networks (water pipes, district heating pipes) that may be threatened by earth crushings due to old sewers. Current renovations methods used in Finland include: (1) studies to determine the extent of groundwater infiltration due to overflow; (2) inspection of sewer systems; (3) diversion of surface waters; (4) reconstruction of sewer lines; and (5) resealing pipelines. (See also W90-02412) (Lantz-PTT)
W90-02414

RENOVATION OF THE STOCKHOLM SEWERAGE SYSTEM.
Stockholm Water and Wastewater Works (Sweden).
P. Sandin.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 21-28.

Descriptors: *Sewers, *Maintenance, *Sweden, Stockholm, Construction methods, Pipes, Water transport, Wastewater facilities.

Within a few years Stockholm will let all its treated wastewater into the Saltsjon, the inner part of the Stockholm Archipelago. In order to prevent overflows 'Plan 83' has been drafted which tells how the sewerage system will be constructed and what measures have to be taken in constructing and operating the system. Renovations of the existing pipes is one method to get a well functioning sewer system. In order to try and develop new techniques and materials in connection with pipe renovation, Stockholm Water and Wastewater Works, in collaboration with the National Swedish Board for Technical Development (STU), has initiated a project for the acquisition of techniques in connection with the renovation of sewers. In order to obtain the views of other Swedish municipalities, a reference group was set up, which includes representatives from a number of municipalities and the Swedish Water and Wastewater Association. The system on which the practical work is to be done is an approximately 700 m-long sewer in Backombergavagen in the west of Stockholm. Also included are a number of 15 m-long house connections that are to be renovated. Attempts will be made to develop methods so that the house connections can be connected to the main sewer without excavation. These methods include: relining, muscle relining, pipe cracking, elastic linings, insituform, copeflex, inpipe system, aqua rings, panels, and pipe-jacking. (See also W90-02412) (Lantz-PTT)
W90-02415

MANAGEMENT OF SEWER OVERFLOW STRUCTURE IN THE FRG.
G. Leymann.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 29-35, 5 fig, 2 ref.

Descriptors: *Storm runoff, *Urban runoff, *Combined sewers, *Combined sewer overflows, *West Germany, *Storm wastewater, *Sewers, Hydraulic structures, Industrial wastewater, Municipal wastewater, Pipes.

Due to the geological morphology of the south and west of West Germany, combined sewer systems are used to drain sewage and rain water in urban areas. In this system, industrial and domestic sewage as well as rain water flowing off areas with sealed surfaces are discharged into one pipe. Size and structure of this sewer systems are designed to fulfill the criterium, that the total amount of water, stemming from rain events of an intensity not to be exceeded more than once a year, can be drained without flooding any part of the area considered. Around the Baltic Sea, sewer systems exist in the central areas of the cities of Lubeck, Schleswig and Flensburg. The remaining communities with more than 2000 inhabitants possess separate sewer systems. For those cities operating a combined sewer system, plans exist for either construction of storm water overflow tanks or separation of rain and sewage waters. In small communities with < 2000 inhabitants, combined sewer systems prevail. Requirements concerning rain water treatment are fulfilled by constructing sewage lagoons. In the West German part of the Baltic Sea area, the sewage water of 90% of all inhabitants are discharged into central sewer systems and dealt with in biological treatment plants. Where separate sewer systems are in use, rain water are discharged into the natural waters directly. Purification steps, such as rain water treatment basins, are required only in special, protected waters. In the case of the storm water overflow tanks, size and structure of rain water treatment basins are based on a critical unit area rainfall of 15 L/sec/ha, which takes care of 90% of all storm water flow-off events. The size of the basins is based on a maximum hydraulic surface load of 9 cu m/sq m/ha. (See also W90-02412) (Lantz-PTT)
W90-02416

CONCENTRATION LIMITS FROM A TECHNICAL STANDPOINT.
K-konsult, Stockholm (Sweden).
J. Rennerfelt.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 36-41.

Descriptors: *Regulations, *Water pollution control, *Hazardous wastes, *Sweden, Municipal wastewater, Industrial wastewater, Organic compounds, Heavy metals, Sulfates, Ammonia, Solvents.

The discharge of hazardous substances in an industrial wastewater can cause a number of negative effects in sewers and treatment plants. Swedish requirements governing the discharge of hazardous substances from industries into municipal sewerage systems have been put together in a list of limit values. The list specifies the maximum concentrations (of sulfates, magnesium, ammonia, toluene, benzene, xylene, chloroform, carbon tetrachloride, trichloroethylene, copper, nickel, chromium, lead, zinc, cadmium, mercury, cobalt) that can be accepted at the connection point between the industrial plant and municipal network with regard to the effect on the sewers, and at the inlet to the treatment plant with regard to the treatment processes. Organic substances have been divided into three groups with regard to their capacity for decomposition in municipal treatment plants, toxicity and risk of biological accumulation in biological sludge and in the natural environment (water recipient and soil). These groups are: treatable, treatable to a limited extent, and non-treatable. Treatable substances, those easily decomposed and with a low level of toxicity, can be discharged to the municipal sewage system provided their concentration in the wastewater is so low that no danger can be anticipated; treatable to a limited extent, are those that are decomposed slowly and/or are toxic, and grouped into three sub-groups where the substances in sub-group (a) are least harmful and those in sub-group (c) most harmful; and non-treatable substances are those that cannot be decomposed in the treatment plant and which can be accumulated in biological sludge and in the natural

environment. These substances should not be discharged to the municipal sewage system. (See also W90-02412) (Lantz-PTT)
W90-02417

LIMIT VALUES IN SPECIAL AGREEMENTS BETWEEN FACTORIES AND SEWAGE WORKS.
Helsinki Metropolitan Area Water Co. (Finland).
Y. Lundstrom.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 42-45.

Descriptors: *Wastewater treatment, *Water quality standards, *Regulations, *Water quality control, *Industrial wastewater, *Finland, Standards, Acids, Bases, Solvents, Cyanide, Heavy metals, Phenols, Organic compounds, Formaldehyde.

The operation of sewage works is controlled in Finland by the water and health authorities. These authorities set quality criteria for the effluent from sewage treatment plants into the recipient system. In order to fulfill the regulations, sewage works impose limit values on factory wastewaters that will ensure there are no problems at the treatment plants. In general, the requirements are fairly similar in all of Finland. Most often the regulations concern the following: operational limitations (of acids, bases, organic solvents, and poisons such as cyanide, formaldehyde and phenol); wastewater control; pretreatment control; duty to inform water authorities; sludge disposal; and amount of heavy metals. (See also W90-02412) (Lantz-PTT)
W90-02418

CONDITIONS FOR INDUSTRIAL EFFLUENT DISCHARGES TO THE MUNICIPAL SEWERAGE SYSTEM.
State Commission for Hydrometeorology Environment Control, Institute of Applied Geophysics, Baltic Branch, Jarvevana tee 5 SU-200001. Tallinn, Estonia, USSR.
E. Loigu, A. Laane, and T. Kriis.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 46-54, 5 tab, 2 ref.

Descriptors: *Water pollution prevention, *Water quality control, *Wastewater treatment, *Regulations, *Industrial wastewater, USSR, Municipal wastewater, Pipes, Chemical oxygen demand, Biochemical oxygen demand, Volatile organic compounds, Organic compounds, Solvents.

Industrial wastewaters in urban areas of the USSR are often jointly treated with municipal sewage waters. Operation of the municipal sewage treatment plant depends substantially on the quality and quantity of industrial wastewater transported to the treatment plant for joint treatment and drainage. In order to guarantee the normal run of the plant a number of normative documents have been formulated to regulate the discharge of industrial effluents to the municipal sewer network. Detailed requirements for individual industrial enterprises have been documented by the local bodies of Water Supply and Sewage Management. The general requirements are: (1) industrial effluents may be discharged to a municipal sewer network if they do not affect the operation of the sewer network or its separate structures; (2) it is prohibited to discharge to municipal sewerage system industrial wastewaters containing substances, which could obstruct the pipes, wells, screens or case deposits on pipe walls, wells and screens; substances impairing the material of pipes and elements of sewerage installation; harmful substances which could hinder the biological treatment process of wastewaters; harmful bacterial contaminants; insoluble oil, resin, fuel oil; concentrated biological heavily oxidizable substances; biologically 'hard' surfactive agents; suspended and volatile solids the concentration of which exceeds 500 mg/L; substances for which limiting permissible concentrations (LPC) have not been established in the water bodies used for drinking, domestic, recreational, and fishing purposes; (3) it is prohibited to discharge to the municipal sewerage system acids, combustible impurities, toxic and soluble gaseous substances (in particular solvents: petrol, diethyl ether, benzene) which may create toxic gases; and (4) it is prohibited to discharge into municipal sewerage system industrial wastewaters with a temperature above 40 C, pH below 6.5 or over 9, chemical oxygen demand 2.5 times higher than biochemical oxygen demand, or concentrated liquors. (See also W90-02412) (Lantz-PTT)
W90-02419

TRACING AND SUPERVISION OF POLLUTANT SOURCES.
T. Palmgren.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 55-68, 5 fig, 1 tab.

Descriptors: *Water quality control, *Wastewater treatment, *Industrial wastewater, *Supervisory control, Water pollution prevention, Organic compounds, Heavy metals, Hazardous wastes, Sweden, Sludge.

Wastewater treatment works in Sweden are mainly built to take care of wastewater from households. The processes are designed to remove organic materials, suspended solids and phosphorus. These substances are called the treatable pollutants. Non-treatable pollutants, such as heavy metals, nondegradable organic substances, and toxic materials, are not to be discharged into the sewer system. The main object of an industrial supervisory group is to keep nontreatable pollutants at as low a level as possible in wastewaters that are to be treated in the wastewater plant. The problem of what to do with the sludge produced has been intensively discussed in Sweden. For a long time, wastewater treatment works have tried to produce a sludge that is well fitted to spreading on arable land. To this end, the tracing and supervision of industrial discharges is essential. The use of hazardous materials in households, and elsewhere in the community, are becoming a substantial source of nontreatable pollutants that still end up in the sludge or are discharged into the receiving waters. Methods for tracing these pollutants are time consuming and expensive. Grab samples can be collected along the sewer lines, or in some cases, a suspected industrial source can be contacted directly. (See also W90-02412) (Lantz-PTT)
W90-02420

PROBLEMS WITH TEXTILE WASTEWATER DISCHARGE.
Tampere Univ. of Technology (Finland).
P. Rantala.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 69-75, 1 fig, 2 tab, 7 ref.

Descriptors: *Textile mill wastes, *Industrial wastewater, *Wastewater treatment, *Wastewater disposal, Pretreatment of water, Neutralization, Municipal wastewater.

Combining textile industry wastewaters with municipal wastewaters is a very common solution especially in the case of small factories. Combined treatment is in general environmentally and economically the best solution. However, a survey revealed that most municipalities experience some problems due to textile industry wastewaters. Combined treatment gives environmentally good and economically justified solution to solve the wastewater disposal problems of textile industry. The character of industrial wastewater must be taken into account on an individual basis in the case of each factory. Textile industry wastewaters can differ very much from one factory to another even if the production processes are close to each other. Pretreatment should be employed to avoid harmful effects of industrial wastes. Neutralization and flow equalization are the most important pretreatment methods but case by case other processes should be involved according to the need. Internal measures to reduce wastewater flow and loading are very important steps which each factory should seriously consider before joining to a municipal sewer. (See also W90-02412) (Lantz-PTT)
W90-02421

REDUCTION OF NITROGEN.
National Board of Waters, Helsinki (Finland).
M. Makela.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 76-91, 8 tab.

Descriptors: *Denitrification, *Wastewater treatment, *Nitrification, Finland, Municipal wastewater, Ammonia, Nitrogen compounds, Activated sludge process.

In Finland nitrogen has been important as a limiting growth factor in some coastal areas and heavily polluted lakes. However, the usefulness of nitrogen removal in municipal wastewater treatment has not been clear enough and requirements concerning removal of total nitrogen have not been set. The need for nitrogen removal depends mainly on the local conditions. On the coastal regions, nitrogen removal should be started first in the biggest municipalities which are discharging into the Gulf of Finland and the Archipelago Sea. The City of Helsinki has to include nitrogen removal before the end of the next decade. The adverse effects of ammonia are apparent in many inland water courses. In recent years reduction of ammonia nitrogen in wastewater treatment has been required in some cases, mainly in order to prevent oxygen depletion caused by nitrification in receiving waters. Other important reasons for ammonia reduction have been the adverse effects of ammonia in the water supply and the toxic effects of molecular ammonia on fish. In practice, ammonia removal has been performed by nitrification in connection with the activated sludge process. The choice of process combinations and design values have always been based on pilot plant or full-scale experiments. In order to reach a long enough sludge retention time during the cold season, the design values for sludge load have been 0.06-0.08 kg BOD/kg mixed liquor suspended solids/d in combined carbon oxidation and nitrification processes. At new nitrification plants, denitrification has been used for diminishing the operation costs. (See also W90-02412) (Author's abstract)
W90-02422

MUNICIPAL WASTEWATER TREATMENT FOR EFFECTIVE REMOVAL OF ORGANIC MATTER AND NITROGEN.
E. V. Grevenevich, N. A. Zaletova, and N. A. Terentieva.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 92-96, 4 ref.

Descriptors: *Municipal wastewater, *Wastewater treatment, *Organic matter, *Activated sludge process, Nitrogen, Denitrification, Biochemical oxygen demand, Chemical oxygen demand, Nitrogen compounds, Phosphates, Activated sludge process, Biodegradation.

Excess concentration of organic matter, nitrogen and phosphorus in receiving waters leads to eutrophication. The nitrogen content in water bodies is standardized according to the sanitary-toxicological criterion of harmfulness: NH4(+) < or 0.39-2,0 mg/L, NO3-N < or = 9.1-10 mg/L. Municipal wastewater usually contains organic matter as estimated by the biochemical oxygen demand (BOD) of 150-200 mg/L and a chemical oxygen demand (COD) of 300-400 mg/L; nitrogen compounds 50-60 mg/L, NH4-N 20-25 mg/L and NOx-N practically absent; total phosphorus in the concentration of 15 mg/L, and PO4(-)-P 5-8 mg/L. The activated sludge process has been most widely used in the USSR for municipal wastewater treatment. This process was heterotrophic and autotrophic microorganisms to consume organic matter, converting wastewater to acceptable forms. C, N and P-containing organic matter is removed from wastewater via biological intake for cell synthesis. C-containing matter is removed by oxidation to CO2 and H2O. P-containing com-

pounds under specific conditions associated with the solid fraction of activated sludge are simultaneously removed from wastewater. The removal of nitrogen, in addition to biosynthesis, is carried out only in the denitrification process, when oxygen from NOx-N is used for the oxidation of organic matter and the gaseous nitrogen produced escapes into the atmosphere. (See also W90-02412) (Lantz-PTT)
W90-02423

EXPERIENCE WITH BIOLOGICAL DENITRIFICATION AT THE HIMMERFJARDEN PLANT.
SYVAB, Himmerfjardsverket, S-14032, GRODINGE, Sweden.
B. G. Hellstrom, J. Bosander, and E. Plaza.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 97-104, 11 fig.

Descriptors: *Denitrification, *Biological wastewater treatment, *Wastewater treatment, *Sweden, Physicochemical treatment, Nitrogen, Phosphorus, Aluminum sulfate, Ferrous sulfate, Sedimentation, Chemical oxygen demand.

The Himmerfjarden Sewage Treatment Plant is situated in the southwestern region of Stockholm, Sweden. The plant serves a population of 230,000 people. The treatment includes mechanical, biological and chemical treatment. The treated water is discharged into the Himmer Bay (Himmerfjarden), which is a bay of the Baltic Sea. Since nitrogen is regarded as the limiting nutrient in the Baltic, nitrogen removal at plants in the coastal region is a concern. At the Himmerfjarden Plant full-scale experiments with biological nitrogen removal have been carried out since 1984. For phosphorus removal, both aluminum sulfate and ferrous sulfate have been used during the test period. The removal efficiency in the primary sedimentation tanks was for suspended solids 60-70%, organic matter (COD) 50-60% and phosphorus 45-55%. The higher figures are with the addition of aluminum sulfate. The usual nitrogen reduction for the plant, without denitrification, is only 10-15%. (See also W90-02412) (Lantz-PTT)
W90-02424

DENITRIFICATION--POSSIBILITIES AND COST ASPECTS.
PURAC A.B., Lund (Sweden).
B. Rosen, and L. Gunnarsson.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 105-129, 12 fig, 6 ref, append.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Denitrification, *Sweden, *Costs, Economic aspects, Activated sludge process, Nitrogen, Cold regions, Biodegradation.

During the last few years, the nitrogen load on some receiving waters in Sweden, has grown to an alarmingly high level. Even if most of the nitrogen can be referred to as diffuse sources from agriculture, nitrogen removal in treatment plants in sensitive areas will be necessary. The development and practical experience of the biological removal of nitrogen has led to good results in warmer climates, using integrated processes. Full-scale operation for nitrification and denitrification has been executed in some existing plants in Sweden with promising results, in spite of low temperatures in the winter. In almost all existing Swedish plants, the biological treatment stage is not designed for nitrification. Because of the actual load, nitrification frequently will occur during the summer. In order to achieve nitrification all the year, the food/microorganism ratio must be decreased, which means either increasing the total active sludge mass in the plant, or lowering the BOD load on the biological stage or possibly a combination of both. The aim of the chosen process mode has been to utilize existing facilities, without too costly an investment. The results show that satisfactory nitrogen removal might be possible to reach, provided that certain criteria can be met. Further studies of the importance of an easy degradable carbon source as well as development of the fixed bed processes and the practical configuration of the process are imperative for good and economical application of the process. (See also W90-02412) (Lantz-PTT)
W90-02425

POSSIBILITIES OF IMPLEMENTING NITROGEN REMOVAL AT SWEDISH WASTEWATER TREATMENT PLANTS.
Swedish Water and Waste Water Works Association, Stockholm.
B. Hultman, E. Plaza, and M. Tendaj-Xavier.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 130-148, 4 fig, 7 tab, 51 ref.

Descriptors: *Nitrification, *Denitrification, *Sweden, *Biological wastewater treatment, *Wastewater facilities, *Wastewater treatment, Biochemical oxygen demand, Municipal wastewater, Sludge digestion.

Problems related to eutrophication and oxygen consumption have been considered as the major factors in deterioration of the water quality in Swedish lakes, rivers and coastal areas. Technical solutions to reduce oxygen-consuming materials and eutrophication have up to now been directed toward the removal of biochemical oxygen demand (BOD) and phosphorus. Thus, biological and chemical treatment of municipal wastewater is usually prescribed, and at present about 90% of the municipal wastewater from Swedish urban areas is treated both biologically and chemically. Although Swedish treatment of municipal wastewater concentrates on the removal of BOD and phosphorus, the environmental and operational effects of nitrogen have been discussed for many years. Plants which can be operated with nitrification may in several cases significantly increase nitrogen removal by introducing an anoxic zone. This zone may be advantageous in saving energy, reducing corrosion, and to some extent reducing the production of sludge. Some operational problems may be incurred as a result of nitrification and denitrification, including floating sludge, corrosion and solubilization of phosphorus. In the implementation of nitrogen removal at existing plants it may be advantageous to consider several modifications, for instance, an increase in the sludge concentration in the aeration basin, use of a separate nitrification or denitrification step before the activated sludge process, and control of the ratio of the aerobic and anoxic zones. (See also W90-02412) (Lantz-PTT)
W90-02426

INCREASE OF THE CAPACITY OF ANAEROBIC SEWAGE SLUDGE STABILIZATION BY THERMAL PRETREATMENT OF THE SLUDGE (STEIGERUNG DER LEISTUNGSFAEHIGKEIT DER ANAEROBEN KLAERSCHLAMMSTABILLSIERURNG DURCH EINE THERMISCHE VORBEHANDLUNG DES SCHLAMMES).
Technische Hochschule Aachen (Germany, F.R.). Gesellschaft zur Foerderung der Siedlungswasserwirtschaft.
J. Pinnekamp.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/A88-80776/GAR. Price codes E07 in paper copy, A01 in microfiche. Gewaesserschutz, Wasser, Abwasser, No. 96, 1987. 297p, 83 fig, 30 tab, 96 ref. English summary.

Descriptors: *Sludge conditioning, *Sludge drying, *Wastewater treatment, Sludge utilization, Pretreatment of sludge, Anaerobic conditions, Pilot plants.

The effects and boundary conditions of thermal pretreatment of sewage sludge at temperatures between 120 and 220 (0)C on a subsequent anaerobic stabilization process were examined. A systematic survey of the known processes for stabilization, conditioning, dewatering and use of sewage sludge is presented. A test plant (laboratory scale, autoclave for preheating the sludge, gas generation tank) study showed that the type of sludge had an important effect on the results of the thermal pretreatment. The rates of increase in gas yield which can be achieved by pretreatment depend on the composition of the sludge. Temperatures between 135 and 180 C were optimal for thermal pretreatment of sewage sludge. No clear effect of the length of pretreatment or of the loading of the subsequent gas generation process was found. The dewatering capacity was appreciably worsened by thermal pretreatment. The thermal pretreatment of sewage sludge before anaerobic stabilization had favorable effects on the energy balance of the sewage plant. (Author's abstract)
W90-02442

DURABILITY OF SEWER PIPES: A LITERATURE STUDY ON DETERIORATION MECHANISMS (DUURZAAMHEID RIOOILEIDINGEN EEN LITERATUURSTUDIE NAAR AANTASTINGSMECHANISMEN).
Commissie voor Hydrologisch Onderzoek TNO, The Hague (Netherlands).
For primary bibliographic entry see Field 8G.
W90-02443

5E. Ultimate Disposal Of Wastes

INTRODUCTION TO THE HYDROGEOCHEMICAL INVESTIGATIONS WITHIN THE INTERNATIONAL STRIPA PROJECT.
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W90-01967

TECHNOLOGIES FOR THE CONTAINMENT, IMMOBILIZATION, AND DISPOSAL OF RADIOACTIVE WASTES.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
J. C. Tait, P. J. Hayward, and J. S. Devgun.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 4, p 444-458, August 1989. 9 fig, 81 ref.

Descriptors: *Waste disposal, *Radioactive wastes, *Reviews, Nuclear powerplants, Radioisotopes, Canada.

Atomic Energy of Canada Limited is developing methods for the management and safe disposal of radioactive wastes. These wastes range from the highly radioactive (high-level) UO2 fuel arising from the nuclear generation of electrical power to the low-level and intermediate-level wastes arising from research in various Canadian institutions using radioactive isotopes. This paper reviews the current research programs on materials and processes for the immobilization and containment of UO2 fuel wastes and the technical aspects of programs demonstrating the various technologies needed for implementing a disposal program for low-level wastes. (Author's abstract)
W90-01980

HIGH-LEVEL NUCLEAR WASTE MANAGEMENT: A GEOCHEMICAL PERSPECTIVE.
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
T. T. Vandergraaf.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 4, p 498-503, August 1989. 29 ref.

Descriptors: *Underground waste disposal, *Radioactive wastes, *Path of pollutants, Waste management, Environmental effects, Geochemistry, Canada.

Atomic Energy of Canada Limited is investigating the concept of the disposal of high-level radioactive waste in an underground vault in an intrusive crystalline rock formation. The environmental impact of such a disposal is, to a large extent, dictated by geochemical processes involving rock-forming minerals, groundwater, and fission products and actinides in the waste. These various geochemical processes impact on the transport of contaminants, including radionuclides and chemi-

cally toxic elements, from a used-fuel disposal vault towards the biosphere. The extent and importance of the geochemical processes on contaminant transport are discussed. The predominant processes controlling the velocity of contaminant transport are the various geochemical interactions of the dissolved contaminant species with the minerals lining the surfaces of conductive fractures and fracture systems. (Author's abstract)
W90-01983

SUITABILITY OF UNCONSOLIDATED SEDIMENTS FOR HOSTING LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES.
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
J. S. Devgun.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 4, p 560-567, August 1989. 6 fig, 2 tab, 25 ref.

Descriptors: *Radioactive wastes, *Waste disposal, *Sand, Environmental engineering, Humid climates, Canada.

Among the unconsolidated sediments, sand deposits are considered a rather unconventional geologic host medium for siting radioactive waste repositories, the clays being the preferred choice. A closer examination of the various geologic media, however, shows that in each case there are advantages and disadvantages. The key to safe and cost-effective disposal is to match the engineered design of the facility to the site's characteristics as well as the nature of the waste to be disposed of. In humid climates, free-draining sediments such as sand can provide the advantage of eliminating concern related to the 'bathtub effect'. At Chalk River Nuclear Laboratories (CRNL), a sand dune has been proposed for hosting a low-level radioactive waste disposal facility. This paper discusses the suitability of unconsolidated sediments for radioactive waste disposal in general; in particular, it provides the rationalization for the selection of a sand dune as the host site at CRNL. (Author's abstract)
W90-01984

ADSORPTION OF HEAVY METAL IONS ON CARBONACEOUS MATERIAL DEVELOPED FROM THE WASTE SLURRY GENERATED IN LOCAL FERTILIZER PLANTS.
Roorkee Univ. (India). Dept. of Chemistry.
For primary bibliographic entry see Field 5D.
W90-02014

SEWAGE SLUDGE DISPOSAL: CURRENT AND FUTURE OPTIONS.
Water Research Centre, Stevenage (England).
A. M. Bruce, and R. D. Davis.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1113-1128, 1989. 2 fig, 3 tab, 42 ref.

Descriptors: *Sludge disposal, *Solid waste disposal, *Sludge utilization, *Ocean dumping, *Land disposal, Agriculture, England, Wastewater treatment, Landfills, Computer programs.

Sewage sludge is an inevitable product of all conventional sludge treatment processes. Disposal of sludge in an economic and environmentally-acceptable manner is becoming generally more difficult. Sludge quantities are rising and disposal options decreasing. Disposal will increasingly require positive and careful management. There are four basic destinations for sludge: agriculture, other types of land, the sea or minor outlets. Treatment methods are available for the production of nine basic types of end-product to suit particular disposal requirements. The new European Community Directive will regulate sludge to agriculture and will require that all sludge to farmland is treated unless it is immediately buried under the soil. Sludge to agriculture (grassland or arable) is subject to soil metal limits and to the need to minimize the risk of disease transmission. Sludge to landfill is subject to increasing constraints, particularly on physical stability. Sludge to sea is still practiced by the UK but is closely controlled by government license and a requirement for monitoring. Minor outlets such as oil production, protein extraction, etc., are only at the experimental level. A computer program (WISDOM) provides a means of evaluating the short/long-term viability of alternative treatment and disposal options to identify the most economic and environmentally-acceptable strategy on an objective basis. (Author's abstract)
W90-02053

AUTOMATION AND OPTIMIZATION OF CENTRIFUGE SLUDGE DEWATERING.
Bonnier Technology Group, Lausanne (Switzerland).
For primary bibliographic entry see Field 5D.
W90-02071

SEWAGE SLUDGE DISPOSAL IN SOUTHERN CALIFORNIA, U.S.A.
QUAD Consultants, Visalia, CA.
W. F. Garber.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1431-1440, 1989. 4 fig, 1 tab, 7 ref.

Descriptors: *Sludge disposal, *Solid waste disposal, *Landfills, *Incineration, *California, Legislation, Operating costs, Ocean dumping, Regulations, Wastewater treatment.

Disposal of sewage solids resulting from wastewater treatment processes has historically been the most difficult and unsolved problem in the handling of water-carried wastes in Southern California. Continuing rapid growth combined with Federal laws which essentially prohibit any discharge of sludge to the ocean regardless of net effects upon the land, water and air total environment have exacerbated this problem to an almost critical state. Complex incineration processes directed at producing energy from dried sludge while minimizing negative atmospheric impacts are under construction. Their complexity has resulted in start-up problems related to the short time allowed for design and break-in by Federal Court action. Increased sludge disposal is also resulting from Federal Court insistence upon full secondary treatment prior to ocean disposal regardless of net environmental impact. Four large facilities were examined: the Sanitation Districts of Los Angeles and Orange Counties, the City of San Diego and the City of Los Angeles. Differing approaches to disposal have been chosen with landfills receiving most sludge at the present and incineration planned for most sludge in the future. Population growth and changes in treatment are expected to increase the amount of sludge needing disposal by about 36% in the next 12-year period. Additionally, while 78% of the total production now goes to landfill, at least 62% is expected to be incinerated in the future. Landfills must still be available for about 24% of the sludge and for the ash. Costs will be substantial since present uses of landfills cost $192 to $215 per dry metric ton and will probably increase; and incineration costs, although presently unknown, appear likely to be at least as expensive because of the need to provide capital recovery to keep complex systems operating. (Sand-PTT)
W90-02080

RECENT ADVANCES IN MECHANICAL DEWATERING OF DIGESTED SLUDGE.
Metropolitan Water Reclamation District of Greater Chicago, IL. Dept. of Maintenance and Operations.
E. W. Knight.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1441-1446, 1989. 4 tab.

Descriptors: *Wastewater treatment, *Sludge drying, *Sludge cake, Centrifugation, Screw press, Diaphragm filter press, Air drying, Anaerobic digestion, Pilot plants, Chicago, Illinois, Sludge disposal, Dewatering.

The present sludge processing operations at the Metropolitan Water Reclamation District of Greater Chicago consist of heated anaerobic digestion, dewatering by centrifugation, and air drying. A critical unit operation in the overall sludge processing train is the mechanical dewatering step. Typically, sludge dewatering by the existing centrifuges produces a cake having a solids content of 15%. Four different types of mechanical sludge dewatering machines were evaluated in a pilot test program to determine if these machines could produce cakes having greater solids contents than that produced from the existing centrifuges. The machines tested were two modified versions of the conventional horizontal solid bowl centrifuge design, a screw press, and a diaphragm filter press. The two modified centrifuges produced cakes having average solids contents of 20% and 29.4%, respectively; the screw press produced a cake having an average solids content of 17.5%, and the diaphragm filter press produced a cake having an average solids content of 29.4%. Based on the pilot test program, a test evaluation program was conducted using full-scale centrifuge machines of the modified designs. The preliminary results of this test confirmed that centrifuges can produce a cake with a solids content approximately equal to or greater than 30%. (Author's abstract)
W90-02081

FULL-SCALE EXPERIENCE WITH SLUDGE TREATMENT AT THE VIENNA SEWAGE WORKS.
Entsorgungsbetriebe Simmering Gesellschaft m.b.H. & K.G., Vienna (Austria).
P. T. Ruggenthaler.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1447-1451, 1989. 3 tab.

Descriptors: *Wastewater treatment, *Water treatment facilities, *Sludge disposal, *Sludge drying, *Dewatering, *Sludge cake, Centrifugation, Filter press, Centripress, Vienna, Austria.

The sewage treatment plant at Simmering, Vienna, has been operating since June 1980, together with the 'EbS' plant for sludge treatment and disposal. The latter consisted of centrifuges, grinder dryers and fluidized bed incineration but due to difficulties with the grinder dryers it has never operated efficiently. Accordingly trials have been done using improved centrifuges and filter presses to increase the dry solids content of the cake fed to the incinerators without using the grinder dryers. It was found that all systems tried were an improvement on the existing but that the best result was achieved using a Centripress on preheated sludge conditioned by polyelectrolyte. The plant was converted to this system in 1987 and results of full-scale operation as well as test results are presented. (Author's abstract)
W90-02082

SYSTEM DESIGN AND FULL-SCALE PLANT STUDY ON A DRYING-INCINERATION SYSTEM FOR SEWAGE SLUDGE.
Kyoto Univ. (Japan). Environment Preservation Center.
S. Sakai, M. Hiraoka, N. Takeda, and I. Ohhama.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1453-1466, 1989. 4 fig, 3 tab, 9 ref.

Descriptors: *Wastewater treatment, *Water treatment facilities, *Sludge cake, *Sludge disposal, *Sludge drying, Dewatering, Incineration, Energy costs, Economic aspects, Japan.

The system design of a drying-incineration process for sewage sludge is discussed using an energy-balance model of the system. In particular, the profitability of this system is considered from the energy and cost points of view. An energy-balance model including drying, incineration, waste heat recovery, and exhaust gas treatment processes was formulated. This showed that autothermic conditions could be established at a lower dewatered cake caloric value, i.e., 350-400 kcal/kg wet solids (WS), in the drying-incineration system, in contrast to the higher dewatered cake caloric value of 700-750 kcal/kg WS necessary to produce autothermic conditions in direct incineration systems. The drying-incineration system had reduced energy costs but involved an increase in investment costs due to construction of the dryer. A full-scale plant was designed at the East Area Sludge Center in Kobe City, Japan. The capacity of one line on this plant is 200 tons of cake per day. From the results

of full-scale operation, fuel oil consumption was 23 L/t cake (at a cake moisture content of 81.2% and a low caloric value of 180 kcal/kg), which is a lower value compared to conventonal incineration systems. (Author's abstract)
W90-02083

CONVERSION OF SLUDGE TO OIL: A NOVEL APPROACH TO SLUDGE MANAGEMENT.
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
H. W. Campbell, and T. R. Bridle.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1467-1475, 1989. 4 fig, 2 tab, 6 ref.

Descriptors: *Wastewater treatment, *Sludge disposal, *Fuel, *Oil, Pilot plants, Thermal conversion, Incineration, Operating costs.

Experiments at the Wastewater Technology Center have shown that low temperature conversion of sludge to oil represents a promising alternative to sludge incineration. A 1 kg/h bench-scale reactor produced oil yields ranging from a low of 13% for an anaerobically digested sludge to a high of 46% for a mixed raw sludge. Char yields ranged from 40-73% at the optimum operating temperatures. Preliminary results from a 40 kg/l pilot plant were similar to those obtained on the bench-scale system with the same sludges. The economics of the conversion process are compared with those for incineration. The impact of the 'sludge to oil' technology on the design of sludge management is also discussed. (Author's abstract)
W90-02084

MERSEY BASIN CAMPAIGN: THE TECHNICAL CHALLENGE.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5G.
W90-02086

MARINE TREATMENT.
Acer John Taylor Ltd., London (England).
P. N. Paul, and F. N. Midmer.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1517-1526, 1989. 11 ref.

Descriptors: *Wastewater disposal, *Ocean dumping, *Diffusers, Water quality, Pipelines, Outfall sewers, England, Design criteria, Construction.

The marine treatment of sewage has become a well established practice in the UK. The technique involves the discharge of sewage through a system of ports or diffusers at a carefully chosen location (often several kilometers out to sea). The studies and investigations that are carried out to determine the most appropriate discharge location and the design of the pipeline and diffuser systems include an understanding of tidal movements, bathymetry, seabed (and sub-seabed) conditions and local marine ecology to predict and confirm that the proposed scheme will achieve the desired water quality and environmental objectives. A conventional long sea outfall consists of a pipeline with the sewage discharged into the sea through a series of riser pipes and diffuser ports at the seaward end. The diffuser system is designed to achieve the maximum initial dilution and subsequent dispersion of the sewage plume. The number of diffuser ports on each riser is normally between 2 and 6 and the spacing of the risers should be sufficient to ensure that the plumes of sewage from the diffuser ports do not impinge on each other before reaching the surface. The design of the outfall system includes both hydraulic and structural considerations. The hydraulic design is affected by a number of factors including pipeline material, while the structural design must satisfy the temporary stresses imposed during construction as well as the long-term loading conditions on the finished pipeline. Marine biological base-line surveys prior to commissioning as well as regular surveys after commissioning, both to ensure the environmental objectives are being met and to monitor the effects of the discharge are necessary. (Author's abstract)
W90-02089

RISK EQUIVALENT SEASONAL WASTE LOAD ALLOCATION.
Environmental Protection Agency, Cincinnati, OH.
L. A. Rossman.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2083-2090, October 1989. 7 fig, 1 tab, 21 ref.

Descriptors: *Wastewater disposal, *Effluent limitations, *Water quality standards, Seasonal variation, Model studies, Case studies, Ammonia, Risks.

Seasonal wastewater discharge programs employ different effluent standards during different times of the year to take advantage of the variation in a receiving water's susceptibility to adverse impacts. These programs should try to achieve the maximum economic benefits possible without increasing the risk of water quality impairment. A method is developed for designing seasonal programs for individual dischargers that limits the risk of one or more water quality standard violations in any year. The key elements involve: (1) treating seasonal receiving water susceptibility to water quality impairment as a random variable; (2) assuming Markov-like behavior of these random variables between seasons; and (3) using a nonlinear programming model to find seasonal discharge limits that minimize waste treatment efforts while maintaining an acceptable annual risk of water quality violation. A case study of controlling ammonia toxicity is presented as well as a comparison of the potential savings available from seasonalization for several pollutants on two rivers with differing seasonal regimes. The results indicate the degree of treatment savings possible from a seasonal discharge program depends on both the pollutant being regulated and the characteristics of the receiving water. The imposition of mandatory minimum treatment standards may also limit the potential benefits of seasonalization. The risk equivalency condition can cause seasonal discharge programs to have a slightly lower minimum discharge limit than the corresponding nonseasonal limit in at least one season of the year. (Author's abstract)
W90-02186

YIELD AND PLANT NUTRIENT CONTENT OF VEGETABLES TRICKLE-IRRIGATED WITH MUNICIPAL WASTEWATER.
Agriculture Canada, Summerland (British Columbia). Research Station.
G. Neilsen, D. S. Stevenson, J. J. Fitzpatrick, and C. H. Brownlee.
Hortscience HJHSAR, Vol. 24, No. 2, p 249-252, April 1989. 4 tab, 19 ref.

Descriptors: *Wastewater irrigation, *Municipal wastewater, *Secondary wastewater, *Trickle irrigation, *Crop yield, Well water, Metals, Zinc, Phosphorus, Sodium, Soil chemistry, Soil properties.

Tomato (Lycopersicon esculentum L.), sweet pepper (Capsicum annuum L.), onion (Allium cepa L.), cucumber (Cucumis sativus L.), bush bean (Phaseolus vulgaris L.), and melon (Cucumis melo L.) were grown from 1983 through 1986 with trickle irrigation using either well water or secondary effluent. Yields with effluent irrigation were greater than or similar to yields obtained with well water. Effluent irrigation resulted in decreased Zn, increased P, and variable results for other nutrients in plant tissues. After 4 years of effluent irrigation, the exchangeable Na content of the 0.0 to 0.3-m depth increased, but soil chemical changes were of little practical significance. No major limitations were found for the production of high yields of vegetables irrigated with municipal wastewater on the loamy sand soil at the experimental site after 4 years. (Author's abstract)
W90-02230

POLLUTION OF QUARTERNARY COVER ON AQUAFERS (SIC) OF EOCENE CHALK IN RAMAT HOVAV INDUSTRIAL AREA IN ISRAEL.
Ben-Gurion Univ. of the Negev, Beersheba (Israel). Dept. of Geology and Mineralogy.
E. Azmon, and Z. Y. Offer.
Water, Air and Soil Pollution WAPLAC, Vol. 44, No. 3/4, p 203-214, April 1989. 6 fig, 1 tab, 16 ref.

Descriptors: *Hazardous materials, *Israel, *Geohydrology, *Waste disposal, Loess, Limestone, Sand dunes, Safety, Aquifers, Geologic fractures.

Ramat Hovav in the Northern Negev of Israel was selected as a site for an industrial park because it had been believed to have the potential to absorb large amounts of hazardous chemical waste liquid and solid materials in the loess layer. The lithology of this site is composed of calcareous loess, sand dunes and underlying limestones. Its soils are loessial serozems, brown lithosols, sandy regosols and arid brown soils. The geomorphology includes specific forms of the Negev desert, such as differentiated relief, slightly dipping level structures, V-shaped canyons, parabolic and sief sand dunes. The hypothetical time span required to totally fill the pore space in the loess, in the total area draining the site selected for study, is more than 400 years. The problem lies in the ability of the rock formations to act as conduit and storage for the toxic waste in a way that will protect the inhabitants from the toxic dangers. Microstructural data are lacking on the 130 m between Eocene saline water chalk aquifer that lies immediately below the loess, and the Cenomanian meteoric water limestone and dolomite aquifer below. Outcrops of the Eocene chalk, however, do show fractures which, if also present in the buried Eocene rocks, may serve as passages for quick leakage of the waste liquids into the underlying rocks. (Author's abstract)
W90-02258

NORTH CAROLINA SANITARY LANDFILLS: LEACHATE GENERATION, MANAGEMENT AND WATER QUALITY IMPACTS.
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W90-02310

SOIL CHEMISTRY AND PHOSPHORUS RETENTION CAPACITY OF NORTH CAROLINA COASTAL PLAIN SWAMPS RECEIVING SEWAGE EFFLUENT.
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 5D.
W90-02314

MARINE TREATMENT OF SEWAGE AND SLUDGE.
For primary bibliographic entry see Field 5D.
W90-02317

LEGISLATION AND FUTURE DEVELOPMENTS IN THE MARINE DISPOSAL OF SEWAGE AND SLUDGE IN THE USA.
Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.
For primary bibliographic entry see Field 5G.
W90-02319

LEGAL AND SCIENTIFIC CONSTRAINTS.
Anglian Water Authority, Norwich (England). Norwich Sewage Div.
For primary bibliographic entry see Field 5G.
W90-02320

SEA OUTFALLS FOR INDUSTRIAL AND URBAN EFFLUENT--FRENCH PRACTICE.
Societe Grenobloise d'Etudes et d'Applications Hydrauliques (France). Applied Mathematics Dept.
B. Quetin.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 69-77, 2 tab, 7 ref.

Descriptors: *Wastewater disposal, *Water pollution control, *France, *Ocean dumping, *Waste

disposal, *France, *Wastewater outfall, *Legislation, *Regulations, Municipal wastewater, Outfall sewers.

French legislation concerning the protection of the sea is based on the recommendations of the European Economic Community and major international agreements. Since 1966, administrative bodies have been set up to control pollution and financing has been allocated for this specific purpose. Large-scale studies have been undertaken to ensure better control of the convection, dispersion and degradation of pollutants discharged into the sea, concentrating on the formation of wind-induced currents, turbulence mechanisms and the processes of bacterial disappearance at sea. Numerous sea outfalls have been constructed along the Mediterranean coast. In contrast, on the Atlantic coast, only industrial concerns have opted for such structures, while municipalities have preferred treatment plants. (See also W90-02317) (Author's abstract)
W90-02322

MARINE DISPOSAL OF SEWAGE AND SLUDGE--AUSTRALIAN PRACTICE.
Metropolitan Water, Sewerage and Drainage Board, Sydney (Australia).
M. W. Whyte.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 79-93, 4 fig, 2 tab, 4 ref.

Descriptors: *Wastewater disposal, *Water pollution control, *Ocean dumping, *Australia, *Waste disposal, *Regulations, Municipal wastewater, Sydney, Waste management, Wastewater outfall.

Almost all Australia's large cities are situated along the coastline and take advantage of the assimilative capacity of the ocean for sewage disposal. An increasing incidence of marine and beach pollution has led to the need for upgrading treatment and disposal arrangements. Some insight is given into how the major sewerage authorities have approached their individual problems. Sydney, in particular, is currently undertaking the largest scheme of all, involving the construction of extended outfalls from all three of its major primary treatment plants. Background information on these outfalls, and the actual construction process is discussed. The Sydney scheme involves the construction of tunnelled outfalls with down-drilled diffuser risers. This decision was made after investigations showed it to be economical and to provide much less risk against damage by anchor chains from large vessels. (See also W90-02317) (Lantz-PTT)
W90-02323

MARINE TREATMENT, DISPOSAL AND PERFORMANCE OF SEWAGE OUTFALL--UK PRACTICE AND EXPENDITURE.
Wessex Water Authority, Bristol (England). Engineering and Operations.
R. Huntington, and P. B. Rumsey.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 95-108, 1 fig, 8 tab, 3 ref.

Descriptors: *Wastewater disposal, *Wastewater treatment, *Ocean dumping, *Great Britain, *Waste disposal, *Water pollution control, *Wastewater outfall, Legislation, Marine environment, Storm-overflow sewers.

The nature of the sewage outfall stock is described with particular reference to historical trends, and the scale and importance of the marine treatment option for sewage in the UK is discussed. There are about 1,000 sewage outfalls around the UK coast. The success of the modern long sea outfalls confirms the acceptable environmental performance of marine treatment using properly designed and constructed outfalls. Water industry capital expenditure on outfalls and public treatment works is estimated at 83 million pounds/yr for the next 10 yrs. with operating costs of 21 million pounds/yr. Particular attention needs to be paid to the design and operation of storm water overflows. To assess fully the effect of storm water overflows on the environment, the designer showed use predictive dispersion and storm flow models. This would permit the determination of the maximum overflow discharge rate and length of overflow pipe consistent with the 'Environmental Quality Objectives'. Attention is drawn to the need to ensure that modern outfalls are designed to safeguard public health and the environment, and not purely to comply with legislation. The desirability of reviewing existing legislation to allow the development of rational criteria for design is discussed, and the issue of storm sewage overflows highlighted. (See also W90-02317) (Author's abstract)
W90-02324

SEWAGE SLUDGE DISPOSAL AT SEA--OPTIONS AND MANAGEMENT.
Ministry of Agriculture, Fisheries and Food, London (England).
M. M. Parker, and A. D. McIntyre.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 123-136, 1 fig, 5 tab, 27 ref.

Descriptors: *Sludge disposal, *Ocean dumping, *Coastal waters, *Wastewater disposal, Fate of pollutants, Organic matter, Nutrients, Heavy metals, Wastewater outfall, Marine environment, Toxicity.

Marine disposal of sewage sludge by vessel or pipeline, properly managed, results in only minor local impact and, as currently practiced, contributes only a small fraction of the total inputs of organic matter, nutrients, heavy metals, and persistent contaminants to the North Sea. Sludge disposal is by no means the only route to the sea of sewage derived materials, which enter also via rivers and direct treated or untreated discharges. However, these sources are more difficult to quantify, being often individual smaller in quantity, very much larger in number, and more diffuse than the large discrete sludge disposal operations carried out in 13 sites around the British coast (from the Firth of Forth in Scotland, all around the English coast, and in the Dublin Bay). There is currently no satisfactory evidence of any other than local effects of sludge disposal operations apart from their relatively minor role in contributing to inputs of persistent substances. (See also W90-02317) (Lantz-PTT)
W90-02325

MARINE DISPOSAL OF SEWAGE SLUDGE BY NORTH WEST WATER AUTHORITY AND STRATHCLYDE REGIONAL COUNCIL.
North West Water Authority, Warrington (England).
E. Harper, and W. T. Greer.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 137-151, 2 fig, 1 tab, 7 ref.

Descriptors: *Ocean dumping, *Sludge disposal, *Wastewater disposal, *England, *Scotland, Liverpool Bay, Garroch Head, History, Fate of pollutants, Environmental effects, Economic aspects.

The North West Water Authority and Strathclyde Regional Council are dependent on marine disposal of sewage sludge by vessel; presently for 1.9 and 1.69 million wet tons respectively/annum. The sites used are contrasting ones--in Liverpool Bay, strong currents ensure rapid dispersion, whereas Garroch Head is an accumulating site. An outline of the historical background, the environment studies, and some reasons why marine disposal is considered the best environmental option are given by each author for his authority. For the disposal of organic matter and reducing the microbiological content of sewage sludge before there is potential contact with man, marine treatment is much more effective than land disposal or inland treatment. The potential problems is the legitimate concern that non-degradable materials and persistent chemicals may accumulate and pass through the food chains to man. However, the cooperation of industry has resulted in reduction of Hg discharge and the fish flesh meets environmental quality standards. In Strathclyde, marine disposal of sewage sludge has been practical for almost 100 yrs. The Strathclyde operation uses an accumulating site at Garroch Head, rather than dispersing the sludge thinly over a wider area and has proven to be an economical and publicly acceptable sludge disposal method. (See also W90-02317) (Lantz-PTT)
W90-02326

SEWAGE TREATMENT STRATEGY FOR THE COLWYN AND ABERCONWY AREAS--AN APPRAISAL OF OPTIONS.
Welsh Water Authority, Powys.
For primary bibliographic entry see Field 5D.
W90-02327

THANET SEWAGE DISPOSAL INVESTIGATION AND THE COMPARISON OF JOINT AND LOCAL SOLUTIONS.
Southern Water Authority, Worthing (England).
For primary bibliographic entry see Field 5D.
W90-02328

ECONOMIC ASSESSMENT OF INLAND TREATMENT AND MARINE TREATMENT OPTIONS FOR WEYMOUTH AND PORTLAND.
Wessex Water Authority, Bristol (England).
For primary bibliographic entry see Field 5D.
W90-02329

SEWAGE SLUDGE TO SEA--THE THAMES WATER APPROACH.
Thames Water Authority, London (England).
M. K. Green, and M. J. Hanbury.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 203-215, 2 tab, 6 ref.

Descriptors: *Wastewater disposal, *Ocean dumping, *Sludge disposal, *Waste management, Costs, Land disposal, Management planning, Economic aspects, Sludge thickening.

Sewage sludge production and disposal to sea from London began in 1889 and the practice has continued for almost 100 years. The present sludge disposal operation run by Thames Water takes 4.2 million wet tons of sludge from four works, Beckton, Crossness, Deephams and Riverside which together serve a population of 4.4 million people. Four ships take the sludge to the Barrow Deep at an annual cost of 4.5 million pounds. Thames Water considers the first step in responsible sludge disposal to be the control of pollutants entering the sludge by effective trade effluent control. The second step, which Thames fully supports, is the concept of Best Practicable Environmental Option as defined in the Oslo Convention. Thames Water's approach to sludge disposal is to continually seek the most managerially responsible disposal route. A recent evaluation covering sea, land, incineration and reuse has identified eighteen options which are thought to be operationally secure. From London, conventional land disposal is not practical leaving only sea disposal, landfill and incineration as viable options. Of those, the sea disposal options are consistently the most economic, land disposal costing approximately 1.5 times and incineration costing twice as much. Sea disposal can be substantially improved by thickening of the sludge, which would minimize transportation costs. (See also W90-02317) (Lantz-PTT)
W90-02330

APPLICATIONS OF RESEARCH DATA TO THE DESIGN AND PERFORMANCE MONITORING OF LONG SEA OUTFALLS.
J. A. Charlton, and P. A. Davies.

IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 243-256, 21 fig, 8 ref. SERC Grant GR/CO 5236 and GR/CO 5274.

Descriptors: *Wastewater disposal, *Wastewater outfall, *Ocean dumping, *Waste disposal, Saline water intrusion, Monitoring.

The results of a combined laboratory and field program of investigations into the phenomenon of salt water intrusion in long sea outfalls, and the consequent effects upon their performance, are described and a hydraulic analysis of the purging process is presented for soffit-connected and invert-connected multi-riser sections. Laboratory data on the form of the head:discharge, characteristics of the outfall system, and the dependencies of effluent plume trajectories and minor loss coefficients upon outlet port geometry, are illustrated. The susceptibility of tunnelled outfalls to intrusion can be reduced significantly by including a venturi constriction in the tunnel just upstream of the diffuser. Primary intrusion control can also be achieved by shaping the discharge port as a diffuser or by the use of a cranked tunnel configuration. Under certain circumstances, total intrusion prevention may be provided by valves, siphon exits, or downward discharging ports. Direct monitoring of outfalls can be achieved by diver surveys and indirect monitoring by adding Rhodamine dye to the effluent at the entry point to the outfall shaft. (See also W90-02317) (Lantz-PTT)
W90-02332

DESIGN AND CONSTRUCTION TECHNIQUES FOR THE FUTURE.
Land and Marine Engineering Ltd., Bebington (England).
J. M. Reynolds, and D. A. Willis.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 257-281, 7 fig, 11 ref.

Descriptors: *Wastewater disposal, *Design standards, *Construction, *Wastewater outfall, Waste disposal, Surveys, Materials engineering, Construction materials.

The first long sea outfall in Europe was constructed in Britain, in the Bristol Channel in 1959 with a single discharge at the end of the pipeline. Five years later, a multiple outlet diffuser system was developed for The Hague outfall, heralding the start of what has now become accepted practice for the dispersion and treatment of sewage and trade effluents into the sea. Long sea outfalls have been constructed with diameters up to 4 m, and lengths approaching 100 m. The task confronting the outfall engineer is to design a pipeline between two predetermined positions: the discharge location, which will have been selected after water movement investigations and dispersion considerations have been considered such that environmental quality objectives are achieved; and, the headworks which would normally be situated at or near to the outfall pipeline landfall. The design and construction processes are considered under four main headings: surveys, designs, materials, and construction. A wide variety of materials are currently available for outfall pipelines and the final selection has to take into account the practicability of construction as well as the corrosive/erosive nature of the effluent to be discharged. The design process, where the selection of the permanent materials is concerned, may well take place before the construction method can be finally decided. This is particularly the case if a design and construct type of contract is envisaged and the possibility of more than one material may well be worth considering in order to afford contractors as much flexibility as possible. The selection of a method (or methods) that will be feasible for a particular outfall location will depend entirely on the circumstances surrounding the proposed route and should be dealt with on a case-by-case basis. (See also W90-02317) (Lantz-PTT)
W90-02333

BEHAVIOR OF DISPERSED AND NONDISPERSED FUELS IN A SEWER SYSTEM.
Environment Canada, Ottawa (Ontario). Environmental Emergencies Technology Div.
For primary bibliographic entry see Field 5B.
W90-02357

URBAN RUNOFF--SWEDISH EXPERIENCE.
National Swedish Environment Protection Board, Solna.
J. Falk.
IN: Seminar on Wastewater Treatment in Urban Areas. Baltic Sea Environment Proceedings, No. 25, 7-9 September 1987, Visby, Sweden. p 2-14, 5 fig, 1 tab, 12 ref.

Descriptors: *Urban runoff, *Sweden, *Sewers, *Costs, *Water pollution control, Economic aspects, Wastewater facilities, Sanitary wastewater, Hydraulic structures, Pipes, Maintenance, Storm water.

During the past 20 years an effort has been made to protect rivers, lakes and the sea from pollution. This effort has mainly been focused on the obvious sources of pollution i.e. the concentrated discharge of sewage. Currently 75% of the urban population is served by advanced treatment plants. The relative importance of the management of storm water and combined sewer overflows increases with the improvement of treatment facilities. The sources are much more difficult to handle as the pollution occurs during single events having a statistically distributed effect on the receiving waters while the discharge of wastewater is fairly stable in quantity as well as quality. In spite of all these difficulties in predicting the quality of stormwater a method was derived to estimate yearly volumes and pollution load via stormwater by means of simple hand calculation procedures. The method is appropriate for areas with a separate storm-water system and gives the direct runoff due to precipitation. Today, Sweden has some 70,000 km of wastewater pipes, 47% of which is for sanitary sewage collection, 39% for storm water collection and 14% for combined water. Annually another 1,700 km are constructed: 60% for sewage water collection and 40% for storm water collection. In 1981, the total investment in sewerage and treatment plants amounted to 230 million SEK. The investment in sewers only amounted to 380 million SEK. The costs for operation and maintenance were estimated at 820 million SEK for treatment plants and 320 million SEK for the sewage network. The costs for operation and maintenance of the sewage network is estimated to be 650 million SEK by 1990. Today, a sewage pipe in Stockholm is renewed on average once every 500 years while the assumed lifetime is less than 100 years. (See also W90-02412) (Lantz-PTT)
W90-02413

INCREASE OF THE CAPACITY OF ANAEROBIC SEWAGE SLUDGE STABILIZATION BY THERMAL PRETREATMENT OF THE SLUDGE (STEIGERUNG DER LEISTUNGSFAEHIGKEIT DER ANAEROBEN KLAERSCHLAMMSTABILLSIERURNG DURCH EINE THERMISCHE VORBEHANDLUNG DES SCHLAMMES).
Technische Hochschule Aachen (Germany, F.R.). Gesellschaft zur Foerderung der Siedlungswasserwirtschaft.
For primary bibliographic entry see Field 5D.
W90-02442

5F. Water Treatment and Quality Alteration

REDUCTION OF ENTERIC INFECTIOUS DISEASE IN RURAL CHINA BY PROVIDING DEEP-WELL TAP WATER.
Shanghai Second Medical Coll. (China).
Z.-S. Wang, D. S. Shepard, Y.-C. Zhu, R. A. Cash, and R.-J. Zhao.
Bulletin of the World Health Organization BWHOA6, Vol. 67, No. 2, p 171-180, 1989. 7 tab, 25 ref.

Descriptors: *Water supply, *China, *Water quality, *Enteric bacteria, *Deep wells, Well water, Cost-benefit analysis.

Enteric infectious disease (EID), defined here as bacillary dysentery, viral hepatitis A, El Tor cholera, or acute watery diarrhea, is an important public health problem in most developing countries. This study assessed the impact on EID of providing deep-well tap water (DWTW) through household taps in rural China. For this purpose, the incidence of EID in 6 study villages (population 10,290) in Qidong County that had DWTW was compared with that in 6 control villages (population 9397) that had only surface water. Both the bacterial counts and chemical properties of the DWTW met established hygiene standards for drinking water. The incidence of EID in the study region was 38.6% lower than in the control region; however, DWTW did not significantly affect the incidence of bacillary dysentery. These results indicate that the construction and use of DWTW systems with household taps is associated with decreased incidences of El Tor cholera, viral hepatitis A, and acute watery diarrhea. A cost-benefit analysis was conducted. The cost of constructing a DWTW system averaged US$10.50 per capita. The combined capital and operating costs were US$1.46 per capita per annum over its 20-year estimated life. The benefits derived from reductions of illness and savings in time to fetch water were 2.2 times the costs at present values. Capital outlays were recouped in a 3.6-year payback period. The provision of DWTW proved highly beneficial in both economic and social terms. (Author's abstract)
W90-01946

DEVELOPMENTAL TOXICITY OF DICHLORACETONITRILE: A BY-PRODUCT OF DRINKING WATER DISINFECTION.
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W90-01948

TUBEWELL WATER CONSUMPTION AND ITS DETERMINANTS IN A RURAL AREA OF BANGLADESH.
International Centre for Diarrheal Disease Research, Dacca (Bangladesh).
For primary bibliographic entry see Field 6D.
W90-01955

PRODUCTION OF BROMINATED METHANES IN DESALINATION PLANTS IN KUWAIT.
Liverpool Univ. (England). Dept. of Oceanography.
M. Y. Ali, and J. P. Riley.
Water Research WATRAG, Vol. 23, No. 9, p 1099-1106, 1989. 4 fig, 4 tab, 17 ref.

Descriptors: *Water pollution sources, *Desalination, *Disinfection, *Chlorine, *Methane, Brominated methanes, Molluscicides, Dissolved solids, Correlation analysis.

Dissolved organic matter in sea water reacts with chlorine used for disinfection and as a molluscicide yielding a mixture of brominated methanes. A study has been made of the formation and distribution of these compounds in the various stages in desalination units of four different plants in Kuwait. Usually bromoform comprised 95-97% of the total, with lesser amounts of dibromochloromethane (2-4%) and traces of dichlorobromomethane (<0.3%). However, exceptionally, in one unit the dichlorobromomethane reached a maximum of 26% when the level of residual chlorine was very low. Over 98% of the haloform formed was discharged to the atmosphere at the deaeration stage. In general, there was a significant to very significant correlation between the concentration of residual chlorine at the pump and that of total haloform present at any particular stage in the unit. Mean total haloform concentrations in the final distillate varied from one unit to another in the range 2.7-22.8 microg/L, and rarely exceeded 30 microg/L, well below the 100 microg/L level set

by the U.S. Environmental Protection Agency. (Author's abstract)
W90-02007

POLYMERIZED AND HYDROLYSED ALUMINUM (III) COMPLEXATION BY SALICYLATE IONS: KINETIC AND THERMODYNAMIC STUDY (COMPLEXATION DE L'ALUMINIUM (III) POLYMERISE ET HYDROLYSE PAR LES IONS SALICYLATE: ETUDE CINETIQUE ET THERMODYNAMIQUE).
Centre National de la Recherche Scientifique, Vandoeuvre-les-Nancy (France). Equipe de Recherche sur la Coagulation-Floculation.
E. Rakotonarivo, C. Tondre, J. Y. Bottero, and J. Mallevialle.
Water Research WATRAG, Vol. 23, No. 9, p 1137-1145, 1989. 7 fig, 4 tab, 22 ref. English summary.

Descriptors: *Water treatment, *Coagulation, *Flocculation, *Aluminum, Thermodynamics, Kinetics, Salicylate ions, Complexation, Mathematical equations, Equilibrium constants.

The Al13 polycation species obtained by hydrolyzing aluminum chloride by sodium hydroxide is the major component of some coagulant-flocculants. These species are of importance in the removal of colloids and organics through coagulation and flocculation in water treatment. The complexation of monomeric and polymeric forms of aluminum with salicylate ions which can be considered as a model system in place of fluvic acids were studied. The stoichiometry and the stability constants of the complexes have been obtained from u.v. and visible spectroscopy and calculated with the Job method. The monomeric and Al13 form complexes with the salicylate ions whose stability constants are 10 to the 5.02 power and >10 to the 20 power, respectively. There are 6 salicylate molecules per Al13. The kinetics of complexation, obtained from stopped-flow measurements are characterized by one relaxation time when the monomers are largely predominant and two relaxation times when Al13 polycations are present. In this last case a kinetic model involving the species Al(H2O)6(3+), Al(OH)(H2O)5(2+), Al(OH)2(H2O)(4+), and Al13 O4(OH)7(24+) accounts well for the experimental results. The kinetics data in combination with literature results concerning the complexation of monomers and the rate constants characterizing the complexation of salicylate ions with Al(OH)2(H2O)(4+): K sub 3 = 2728/ M/s. In the presence of Al13 polycations, the relaxation theory leads to differential equations which allows the calculation of k sub p = 3679 +or-113 /M/s at 25 C. The equilibrium constant and the rate constant relative to Al13 salicylate indicate both a high stability and a faster reaction with Al13 than with monomers. (Author's abstract)
W90-02011

OVERVIEW OF THE TRENDS AND FUTURE DIRECTION OF INFORMATION TECHNOLOGY IN THE WATER INDUSTRY.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 10D.
W90-02054

DESIGN OF ACCIDENTAL POLLUTION ALARM SYSTEMS.
Compagnie Generale des Eaux, Paris (France).
J. M. Philipot, J. P. Coutant, and P. Mousty.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1261-1270, 1989. 5 fig, 9 ref.

Descriptors: *Drinking water, *Water quality control, *Water treatment, *France, *Monitoring, *Alarm systems, Water pollution sources, Accidents, Safety.

Water supplies to the Syndicat des Eaux d'Ile de France (Ile de France Water Board) subscribers are provided by Compagnie Generale des Eaux using treated water from three rivers (Seine, Marne, Oise). These rivers cross densely populated, industrial areas and so are exposed to quite significant pollution hazards. The guarantee of safe supplies involves a monitoring and alarm policy that will enable the various emergency measures provided in water works and pipe networks to be initiated rapidly. This system is based on the following steps: compilation of accidental pollution history; inventory of hazardous sites; study of treatment process response; location and choice of parameters for the automatic analyzing stations. A system of this type set up on the River Marne consisted of the following unit: (1) the Gournay-sur-Marne automatic station, (2) a hydrocarbon indicator, (3) a pesticide detector, and (4) peripheral alarm stations. The cost of these systems and the level of competency required to operate them restricts them to large-scale water systems. (Sand-PTT)
W90-02065

APPLICATION OF INFORMATION SYSTEMS AND TELEMETRY TO OPERATIONAL MANAGEMENT IN ANGLIAN WATER.
Anglian Water Authority, Huntingdon (England).
J. W. Green, C. Page, G. M. Eastman, and D. Howes.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1283-1294, 1989. 1 fig, 2 tab.

Descriptors: *Water management, *Water treatment, *Information systems, *Telemetry, *Control systems, Mapping, England, Computers.

An account is given of the development of information systems in Anglian Water to meet the requirements of operational management. An overview of the new computing network for operations applications is presented, including the Operations Information System, a comprehensive operational job management system, and digital mapping. Telemetry systems, which will eventually extend to over 5500 sites, are being implemented. The principal objectives to be met by installing telemetry systems are: (1) to provide operational data, including the alarm state of the plant, to allow a prompt response to faults; (2) to provide adequate monitoring of the performance of unmanned facilities to reduce the frequency of visits; (3) to reduce the number of continuously-manned facilities and operations centers; (4) to collect and store operational statistics for management reports; (5) to provide a means of remotely operating or automatically operating plants; and (6) to improve performance by the development of techniques such as pump scheduling, flood forecasting, and leakage control. The implementation of these systems has involved close cooperation between Anglian Water and Logica Electronic Information Systems, Ltd. The software is being developed in a modular format, based on discrete processes; the key requirement is that it is reusable from site to site. A variety of configuration techniques is being employed to achieve this. The benefits resulting from the modular approach are: (1) a standardized control methodology, (2) reduced levels of skill required to implement process control of sites, (3) reduced documentation quantity, (4) easier and better maintenance of hardware and software due to standardized interfaces and better knowledge of the system, and (5) lower overall system costs. The process control software modules will be able to be installed into telemetry outstations and issued to a contractor as a complete monitoring and control system. (Sand-PTT)
W90-02067

ICA: EVOLUTION IS BETTER THAN REVOLUTION.
South Staffordshire Waterworks Co., Walsall (England).
For primary bibliographic entry see Field 7B.
W90-02072

ENHANCING AS(5+) REMOVAL BY A FE(2+)-TREATED ACTIVATED CARBON.
Delaware Univ., Newark. Dept. of Civil Engineering.
C. P. Huang, and L. M. Vane.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1596-1603, September 1989. 12 fig, 1 tab, 18 ref.

Descriptors: *Arsenic, *Activated carbon, *Water treatment, Adsorption, Iron, Hydrogen ion concentration, Ferrous salts, Removal capacity.

The effectiveness of pretreating an activated carbon with iron-salt solution to improve its arsenic removal capacity was studied. Various factors such as type and concentration of salt, pH, and treating time were thoroughly investigated for their effects on the improvement of removal capacity. Soaking activated carbon in ferrous salt solutions was effective in improving its arsenic removal capacity, and also in the regeneration of the spent carbon. Ferrous perchlorate solutions were the most efficient solutions for improving the removal capacity of the carbon. The removal depended on the carbon surface characteristics, which were improved by the iron treatment, primarily the iron loading. The pH sub Zpc was higher than that of acid-washed carbons yielding a positively charged surface at lower pHs. The pH sub Zpc increased with the amount of iron adsorbed as did the removal capacity. The improved removal can be attributed to the formation of ferrous arsenate surface complexes and not to the formation of precipitates in the bulk solution. The regeneration of spent carbon with ferrous salt solutions yielded a carbon with an unlimited removal capacity. A ten-fold increase, over the untreated activated carbon, in removal can be achieved under the optimal pretreatment procedure. The enhancement in removal by treatment occurs by adsorption of ferrous ions and formation of arsenate complexes. Ferrous salts can also be used to regenerate the activated carbon. (Author's abstract)
W90-02109

ISOLATION OF AEROMONAS SPP. FROM WATER BY USING ANAEROBIC INCUBATION.
South Australia Engineering and Water Supply Dept., Salisbury. State Water Labs.
D. A. Cunliffe, and P. Adcock.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2138-2140, September 1989. 1 fig, 3 tab, 17 ref.

Descriptors: *Drinking water, *Bacterial analysis, *Aeromonas, Membrane filters, Filtration, Water analysis.

A membrane filtration method incorporating a combination of anaerobic and aerobic incubation was developed for the enumeration of Aeromonas spp. in drinking water. The use of anaerobic incubation improved the detection of Aeromonas spp. by reducing the growth of nonaeromonads. The confirmation rate of presumptive Aeromonas spp. identified on the initial isolation agar exceeded 92%. (Author's abstract)
W90-02163

DETECTION OF ACINETOBACTER SPP. IN RURAL DRINKING WATER SUPPLIES.
West Virginia Univ., Morgantown. Div. of Plant and Soil Sciences.
J. M. Bifulco, J. J. Shirey, and G. K. Bissonnette.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2214-2219, September 1989. 2 tab, 55 ref.

Descriptors: *Drinking water, *Groundwater pollution, *Bacterial analysis, *Pathogenic bacteria, *Acinetobacter, *Coliforms, West Virginia, Bioindicators, Water analysis, Well water.

A bacteriological survey was conducted of untreated, individual groundwater supplies in Preston County, West Virginia. Nearly 60% of the water supplies contained total coliforms in excess of the U.S. Environmental Protection Agency maximum contaminant level of 1 CFU/100 ml. Approximately 1/3 of the water systems contained fecal coliforms and/or fecal streptococci. Acinetobacter spp. were detected in 38% of the groundwater supplies at an arithmetic mean density of 8 CFU/100 ml and were present in 16% of the water supplies in the absence of total coliforms, posing some concern about the usefulness of total coli-

forms as indicators of the presence of this opportunistic pathogen. Slime production, a virulence factor for A. calcoaceticus, was not significantly different between well water isolates and clinical strains, suggesting some degree of pathogenic potential for strains isolated from groundwater. In addition, several Acinetobacter isolates were able to interfere with sheen production by some coliform bacteria on M-Endo medium, adding further to the possible significance of Acinetobacter spp. in groundwater supplies. (Author's abstract)
W90-02165

DISINFECTION OF MODEL INDICATOR ORGANISMS IN A DRINKING WATER PILOT PLANT BY USING PEROXONE.
Southern California Metropolitan Water District, La Verne.
R. L. Wolfe, M. H. Stewart, S. Liang, and M. J. McGuire.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2230-2241, September 1989. 11 fig, 3 tab, 47 ref.

Descriptors: *Drinking water, *Water treatment, *Disinfection, *Ozonation, *Ozone, *Hydrogen peroxide, *PEROXONE process, *Bactericides, *Viricides, *Pilot plants, Escherichia coli, Bacteriophage, Chlorination.

PEROXONE is an advanced oxidation process generated by combining O3 and H2O2. This process stimulates the production of hydroxyl radicals, which have been shown to be superior to ozone for the destruction of some organic contaminants. Pilot-scale experiments were conducted to evaluate the microbicidal effects of PEROXONE and O3 against three model indicator groups. Escherichia coli and MS2 coliphage were seeded into the influent to the preozonation contactors of a pilot plant simulating conventional water treatment and were exposed to four O3 dosages (0.5, 1.0, 2.0, and 4.0 mg/l), four H2O2/O3 weight ratios (0, 0.3, 0.5, and 0.8), and four contact times (4, 5, 12, and 16 min) in two source waters--Colorado River water and state project water, of different quality. The removal of heterotrophic plate count bacteria was also monitored. The microbicidal activity of PEROXONE was greatly affected by the applied O3 dose, H2O2/O3 ratio, contact time, source water quality, and type of microorganism tested. At contact times of 5 min or less, O3 alone was a more potent bactericide than PEROXONE at all H2O2/O3 ratios tested. However, this decrease in the bactericidal potency was dramatic only as the H2O2/O3 ratio was increased from 0.5 to 0.8. The fact that the bacteridical activity of PEROXONE generally decreased with increasing H2O2/O3 ratios was thought to be related to the lower O3 residuals produced. The viricidal activity of PEROXONE and O3 was comparable at all of the H2O2/O3 ratios. Heterotrophic plate count bacteria were the most resistant group of organisms. Greater inactivation of E. coli and MS2 was observed in Colorado River water than in state project water and appeared to result from differences in the turbidity and alkalinity of the two waters. Regardless of source water, >4.5 log10 of E. coli and MS2 was inactivated at an applied O3 dosage of 2.0 mg/l (and a 4-min contact time) when the H2O2/O3 ratio was < or = 0.5. Comparative disinfection experiments indicated that free chlorine was the most potent agent, followed by ozone, PEROXONE, and chloramines. These results indicate that the PEROXONE process must be optimized for each source water to achieve microbicidal effectiveness. (Author's abstract)
W90-02166

REMOVAL OF NITRATES FROM WELLWATER BY MEMBRANE PROCESSES. FINAL REPORT (NITRATENTFERNUNG AUS GRUNDWAESSERN MITTEIS MEMBRANVERFAHREN. SCHLUSSBERICHT) (IN GERMAN).
Technische Hochschule Aachen (Germany, F.R.). Inst. fuer Verfahrenstechnik.
R. Rautenbach, W. Kopp, G. van Opbergen, T. Peters, and R. Hellekes.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-80458/GAR. Price codes: E11 in paper copy, A01 in microfiche. Report no. BMFT-FB-T 86-137. 118p, 79 fig, 27 tab, 31 ref. English summary.

Descriptors: *Water treatment, *Nitrates, *Membrane processes, *Reverse osmosis, Electrodialysis, Brines.

A nitrate-separation pilot plant with low brine discharge has been installed in the municipal waterworks at Moenchengladbach-Gatzweiller. The essential parts are a reverse osmosis (RO) and an electrodialysis (ED) unit. The capacity of the RO-unit is 2 cu m/hr. At present the total operating time is about 17,000 hr, using the original set of membranes. The quality of the permeate allows a blending with untreated well water. Electrodialysis with reversal permits operation at very high recovery rates and has been employed for further concentration of the RO-concentrate and for the direct treatment of the well water. The highest recovery rates have been achieved by a combination of RO, cation exchange, and ED, despite the ion exchange eluates which increase the total brine flow. Unfortunately, the amount of dissolved solids is considerably increased in this case by the NaCl necessary for regenerating the ion-exchanger. High water recovery rates of the membrane processes are mandatory in all cases where the brine discharge is costly or where evaporation of the brines is considered. Based on the results of the experiments, cost estimates for a plant with a capacity of 3,100,000 cu m/yr feed indicate the superiority of RO as long as the brine can be discharged without cost. The cost advantage increases with increasing nitrate-feed concentration. Electrodialysis with reversal is superior in cases where high water recoveries are demanded or where the dissolved solids have to be discharged ultimately in solid form. (Author's abstract)
W90-02441

5G. Water Quality Control

METHODOLOGY FOR ASSESSMENT OF CONTAMINATION OF THE UNSATURATED ZONE BY LEAKING UNDERGROUND STORAGE TANKS.
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 5B.
W90-01944

GWALTNEY OF SMITHFIELD V. CHESAPEAKE BAY FOUNDATION: BALANCING INTERESTS UNDER THE CLEAN WATER ACT.
For primary bibliographic entry see Field 6E.
W90-01945

MODELLING WATER QUALITY OF A REREGULATED STREAM BELOW A PEAKING HYDROPOWER DAM.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
M. J. Zimmerman, and M. S. Dortch.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 235-247, September/October 1989. 12 fig, 1 tab, 10 ref.

Descriptors: *Dam effects, *Hydroelectric plants, *Reservoir releases, *Regulated flow, *Model studies, Hydraulic structures, Dams, Weirs, Locks, Water quality, Dissolved oxygen, Temperature, Ammonium, Nitrates, Biochemical oxygen demand, Metals, Flow pattern.

A dynamic, one-dimensional, stream water quality model (CE-QUAL-RIV1) capable of simulating branched riverine systems with multiple hydraulic control structures, such as weirs, reregulation dams, and navigation locks and dams is presented. Potential water quality impacts associated with operation alternatives for a reregulation dam proposed for construction downstream from Buford Dam on the Chattahoochee River near Atlanta, Georgia suggest summer water temperature and autumn DO and dissolved metals concentrations at this site constitute major concerns. The model can be used to focus on transient water quality conditions resulting from unsteady flows on regulated streams. The model was calibrated for stage, transport, temperature, dissolved oxygen, carbonaceous biochemical oxygen demand, ammonium-N, and nitrate-N. The results show the difficulties which may arise from using a single operations plan throughout the year. A zero-flow minimum release may keep downstream DO relatively high and dissolved iron concentration low when the upstream impoundment is strongly stratified. However, the same release pattern, during the warmest part of the summer can cause downstream temperature increases, relative to a low-flow release. Therefore, potentially deleterious effects of the operation scenarios can be ameliorated using a flexible seasonal release plan based on knowledge of in-pool water quality and likely meteorollogical conditions. (Author's abstract)
W90-02044

MANAGING FRESHWATER INFLOW TO THE SAN FRANCISCO BAY ESTUARY.
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 2L.
W90-02048

APPLICATION OF A WATER QUALITY INDEX TO RIVER MANAGEMENT.
North West Water Authority, Warrington (England).
For primary bibliographic entry see Field 5A.
W90-02056

MERSEY BASIN CAMPAIGN: THE TECHNICAL CHALLENGE.
North West Water Authority, Warrington (England).
B. Alexander, and E. Harper.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1489-1498, 1989. 3 fig, 8 ref.

Descriptors: *Watershed management, *Wastewater management, *Sewer systems, *Water pollution control, *Wastewater treatment, *Urban planning, Mersey River, England, Management planning, Project planning, Water quality, Industrial wastewater.

The Mersey Basin Campaign is a major initiative launched in 1984 to revitalize the river system of the River Mersey in England and the adjacent waterfront. The long-term program of major investment by North West Water to tackle the seriously polluted conditions of the river and estuary of the basin forms the central core of the Campaign. This program provides for the substantial improvement of the aging and inadequate sewerage and sewage disposal systems. This paper reviews the technical challenges facing North West Water in the investigations, research and plans to meet the objectives for river water quality throughout the basin are reviewed. The extensive pollution and the exceptional concentration of urban development and population require the production of integrated catchment plans for the most cost-effective investments for the achievement of modern environmental standards. The complex investment choices will require optimum solutions for the achievement of the right infrastructure balance between improved sewerage systems and effective sewage treatment. A key feature of the Campaign has been the commitment in terms of considerable financial support from the European Community. (Author's abstract)
W90-02086

RIVER BASIN MANAGEMENT IN SCOTLAND.
Clyde River Purification Board, East Kilbride (Scotland).
D. Hammerton.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1501-1508, 1989. 2 fig, 6 ref.

Descriptors: *Watershed management, *Water pollution control, *Scotland, *Water quality manage-

ment, Inland waterways, Coastal waters, Regulations, Water resources development.

The seven river purification boards, which cover the whole of mainland Scotland, are strictly single-purpose authorities whose function is to control pollution of inland and coastal waters. Unlike the water authorities in England and Wales they are not responsible for the management of water supplies, sewerage, sewage treatment, land drainage, flood prevention or fisheries. However, it is this singleness of purpose and the complete independence of the boards from the polluters, whether local authorities or private industries, which has led to better progress in the restoration of polluted waters in Scotland than south of the border, progress which has been clearly demonstrated in recent government reports. Moreover, through close consultation at the planning stage with government departments, local authorities and other bodies, the river boards do have a significant influence on developments which affect the aquatic environment and hence are involved in the wider aspects of river basin management. (Author's abstract)
W90-02087

RIVER BASIN MANAGEMENT IN NORTHERN IRELAND.
Department of the Environment for Northern Ireland, Belfast. Water Service - Eastern Div.
D. Logan.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1509-1515, 1989. 5 fig, 1 tab.

Descriptors: *Watershed management, *Water quality, *Northern Ireland.

The Environmental Protection Division (EPD) within the Department of the Environment has responsibility for river water and coastal water quality in Northern Ireland. EPD issues discharge consents for both public and private discharges to water courses consistent with its program of protecting and improving water quality. EPD also monitors both river and coastal waters as well as bathing beaches. Water quantity and quality data are maintained on a computer data base and information is published for public information. This data base is also essential to calculate the effects of discharges on water quality and to guide EPD is assessing the required standards for new discharges. The complete range of water supply and sewerage services are operated by the Northern Ireland Water Service which is part of the Department of the Environment. Design of major works, Resource Planning and Research and Development are the responsibility of the Director of Development. Half of the design work is carried out by Water Service staff, the remaining half being undertaken by private firms of Consulting Engineers. All major schemes are constructed by private contractors tendering in open competition for this work. (Sand-PTT)
W90-02088

CSO ABATEMENT FOR THE LOWER CONNECTICUT RIVER IN MASSACHUSETTS.
Metcalf and Eddy, Inc., Wakefield, MA.
For primary bibliographic entry see Field 5D.
W90-02101

CHEMICAL RESPONSE FOLLOWING BASE APPLICATION TO LITTLE SIMON POND, NEW YORK STATE.
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
D. C. McAvoy, and C. T. Driscoll.
Journal - Water Pollution Control Federation JWPFA5, Vol. 61, No. 9, p 1552-1563, September 1989. 8 fig, 1 tab, 27 ref.

Descriptors: *Acid rain, *Acid lakes, *Lake restoration, *New York, *Liming, Hydrogen ion concentration, Acid neutralizing capacity, Mixing, Thermal stratification.

Little Simon Pond, a moderately acidic lake located in the Adirondack region of New York State, was treated during August 1986 by application of three particle sizes of limestone (CaCO3), ranging from finely ground (14 microm) to coarsely ground (40 microm). Immediately after base addition, there was a marked increase in pH, acid neutralizing capacity (ANC), and Ca(2+) associated with the dissolution of CaCO3. Water quality targets (pH greater than 6.5, ANC greater than 100 microeq/L) were immediately met in the epilimnion, and approximately 2 months after treatment were attained in the hypolimnion. This delayed response in the lower waters was due, in part, to restricted water column mixing as a result of thermal stratification both prior to and following the treatment. Short-term reacidification occurred during the snowmelt period and was limited to the upper waters after 1 year of treatment. Results show that application of multiple limestone particle sizes may be a useful method for mitigating acidification in thermally stratified lakes like Little Simon Pond. (Author's abstract)
W90-02105

GEOLOGY AND HYDROLOGY OF THE DEEP SUBSURFACE MICROBIOLOGY SAMPLING SITES AT THE SAVANNAH RIVER PLANT, SOUTH CAROLINA.
Furman Univ., Greenville, SC. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W90-02118

FACTORS CONTROLLING THE REMOVAL OF SULFATE AND ACIDITY FROM THE WATERS OF AN ACIDIFIED LAKE.
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
A. T. Herlihy, and A. L. Mills.
Water, Air and Soil Pollution WAPLAC, Vol. 45, No. 1-2, p 135-155, May 1989. 7 fig, 6 tab, 34 ref. N.S.F. Grant No. DEB82-06827.

Descriptors: *Virginia, *Lake restoration, *Acid mine drainage, *Sulfates, *Acid streams, Iron, Seasonal variation, Temperature, Oxidation, Sediments.

Although Lake Anna, an impoundment in Central Virginia, receives acid mine-drainage (AMD) from Contrary Creek, the effects of the AMD pollution on the lake are less severe than expected. Previous work at Lake Anna has shown that bacterial sulfate reduction in the lake sediments plays an important role in the recovery of the lake from the AMD inputs. Sulfate removal rates were measured in sediment microcosms under a variety of experimental conditions to determine the factors controlling the rate of sulfate and acidity removal from the lake water. Sulfate removal rates were not significantly different over the short term (3 weeks) in summer sediment microcosms incubated at 6 vs 26 C. Winter sediment microcosms showed no significant sulfate removal during the 18 day experiment when incubated at either 6 or 28 C. Thus there is a strong seasonal temperature effect in Lake Anna sediments but no significant short term effect. Simulated AMD, with and without Fe, was added to sediment microcosms collected from an unpolluted part of the lake. The microcosms with Fe had significantly higher rates of sulfate removal indicating the Fe plays an important role in transporting sulfate to the sediment and/or in preventing oxidation of the reduced sulfide. After 27 days, from 54 to 96% of the added sulfate in the simulated AMD was recovered as FeS or S(o) in the top 4 cm of sediment. In a separate experiment, 35S-SO4(2-) was found to attach to precipitating Fe oxyhydroxides (1.5 to 4.7 mol SO4(2-)/mol Fe precipitate) upon mixing Contrary Creek (AMD) and Lake Anna waters. Results of this study suggest that sulfate removal may be more rapid in metal rich AMD systems than in metal poor systems characteristic of those which receive acidic deposition. (Author's abstract)
W90-02160

BIOLOGICAL REDUCTIVE DECHLORINATION OF TETRACHLOROETHYLENE AND TRICHLOROETHYLENE TO ETHYLENE UNDER METHANOGENIC CONDITIONS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
D. L. Freedman, and J. M. Gossett.
Applied and Environmental Microbiology AEMIDF, Vol. 55, No. 9, p 2144-2151, September 1989. 6 fig, 3 tab, 30 ref. Air Force Engineering and Services Center, Tyndall AFB, Fla., contract F08635-86-C-0161.

Descriptors: *Groundwater pollution, *Chlorinated hydrocarbons, *Biodegradation, *Biotransformation, *Microbial degradation, *Methane bacteria, *Water pollution treatment, Decontaminants, Tetrachloroethylene, Trichloroethylene.

A biological process for remediation of groundwater contaminated with tetrachloroethylene (PCE) and trichloroethylene (TCE) can only be applied if the transformation products are environmentally acceptable. Studies with enrichment cultures of PCE- and TCE-degrading microorganisms provide evidence that, under methanogenic conditions, mixed cultures are able to completely dechlorinate PCE and TCE to ethylene, a product which is environmentally acceptable. Radiotracer studies with C14-PCE indicated that C14-ethylene was the terminal product; significant conversion to C14-CO2 or C14-CH4 was not observed. The rate-limiting step in the pathway appeared to be the conversion of vinyl chloride to ethylene. To sustain reductive dechlorination of PCE and TCE, it was necessary to supply an electron donor; methanol was the most effective, although hydrogen, formate, acetate, and glucose also served. Studies with the inhibitor 2-bromoethanesulfonate suggested that methanogens played a role in the observed biotransformations of PCE and TCE. (Author's abstract)
W90-02164

MICROBIAL ADAPTATION TO DEGRADATION OF HYDROCARBONS IN POLLUTED AND UNPOLLUTED GROUNDWATER.
Copenhagen Univ. (Denmark). Dept. of General Microbiology.
J. Aamand, C. Jorgensen, E. Arvin, and B. K. Jensen.
Journal of Contaminant Hydrology JCOHE6, Vol. 4, No. 4, p 299-312, September 1989. 6 fig, 3 tab, 19 ref.

Descriptors: *Water pollution treatment, *Oil spills, *Microbial degradation, *Biodegradation, *Hydrocarbons, *Groundwater pollution, *Adaptation, Water pollution effects, Oil, Gasoline, Aquifers, Bacteria.

Microbial adaptation to degradation of aromatic hydrocarbons in heavily polluted, slightly polluted and unpolluted groundwater was examined. The adaptation of bacteria from aquifers polluted by fuel oil and gasoline were also compared. The compounds used as substrate were: toluene, o-xylene, 1,3,5-trimethylbenzene, naphthalene, 1-methylnaphthalene, biphenyl, 2-ethylnaphthalene, and 1,4-dimethylnaphthalene. Initial concentrations of each component ranged from 100 microg/L to 240 microg/L. A simple batch technique was used. The lengths of the lag periods were used to express the degree of adaptation to degradation of the hydrocarbons. In one experiment equal volumes of groundwater from the three sites were used as inoculum. In another equal microbial numbers in the bottles were ensured by adding different volumes of groundwater. The bacterial community in the heavily polluted well had a higher degree of adaptation to hydrocarbon degradation than the community from the slightly polluted well. The bacteria from the unpolluted well are considered as being unadapted, because of long lag periods compared to the bacteria in the polluted wells (7 to 34 times longer). The sequence in which the compounds were degraded after inoculation with fuel oil polluted or gasoline polluted groundwater is related to the occurrence of these compounds in the water soluble fractions of the two petroleum products. Addition of soil reduced the lag periods in the bottles inoculated with heavily polluted groundwater, while no or minor effects were observed when the soil was added to the bottles inoculated with slightly or unpolluted groundwater. During the experiments an increase in ATP content was observed. (Author's abstract)

W90-02180

RELIABLE AQUIFER REMEDIATION IN THE PRESENCE OF SPATIALLY VARIABLE HYDRAULIC CONDUCTIVITY: FROM DATA TO DESIGN.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
B. J. Wagner, and S. M. Gorelick.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2211-2225, October 1989. 12 fig, 2 tab, 36 ref.

Descriptors: *Water pollution treatment, *Aquifer remediation, *Groundwater management, *Geohydrology, *Hydraulic conductivity, Mapping, Model studies, Simulation analysis, Spatial variability, Hydraulic head, Groundwater quality, Monte Carlo method.

Most optimization models for groundwater management have ignored the effects of uncertainty due to spatial variability of hydraulic conductivity. This uncertainty is explicitly incorporated into a procedure for the optimal design of aquifer remediation strategies. Local hydraulic conductivity and head data are used to quantify the uncertainty which is traced through to target a reliable remediation design. The management procedure is based on the stochastic approach to groundwater flow and contaminant transport modeling, in which the log-hydraulic conductivity is represented as a random field. The remediation design procedure has two steps. The first is solution of the stochastic inverse model. Maximum likelihood and Gaussian conditional mean estimation are used to characterize the random conductivity field based on the hydraulic conductivity and hydraulic head measurements. Based on this statistical characterization, conditional simulation is used to generate numerous realizations (maps) of spatially variable hydraulic conductivity that honor the head and conductivity data. The second step is solution of the groundwater quality management model. Two management model formulations are presented. The first, termed the multiple realization management model, simultaneously solves the nonlinear simulation-optimization problem for a sampling of hydraulic conductivity realizations. It is shown that reclamation design based on as few as 30 conductivity realizations can provide reliable (over 90%) remediation strategies. The second model, termed the Monte Carlo management model, solves the nonlinear simulation-optimization problem individually for a sampling of hydraulic conductivity realizations. This provides a relationship between pumping (cost) and reliability. Each of the management models is linked with the stochastic inverse model, and each is demonstrated for two cases: (1) the available data are limited to hydraulic conductivity measurements and (2) both hydraulic conductivity and hydraulic head measurements are used. (Author's abstract)
W90-02200

COPPER MOLLUSCICIDES FOR CONTROL OF SCHISTOSOMIASIS. 1. EFFECT OF INORGANIC COMPLEXES ON TOXICITY.
Sussex Univ., Brighton (England). School of Chemistry and Molecular Sciences.
T. N. O'Sullivan, J. D. Smith, and J. D. Thomas.
Environmental Science and Technology ESTHAG, Vol. 23, No. 9, p 1102-1106, September 1989. 3 fig, 3 tab, 35 ref.

Descriptors: *Schistosomiasis, *Snails, *Copper, *Pesticide toxicity, *Molluscicides, Toxicity, Water quality control, Malachite.

A flow system has been developed for the assessment of copper toxicity toward the snail Biomphalaria glabrata using a standard medium in which cupric ion speciation is well-defined. This allows the effects of complexing agents generated by the snail to be controlled. Dose-response curves show that the toxicity closely follows the sum of the concentrations of the species Cu(2+)(aq) and CuOH(+)(aq), indicating that other copper species are considerably less toxic. Copper molluscicides are most effective at pH 7. At lower pH metal uptake is reduced by competition from H(+) at active sites and at higher pH by complexation with OH(-) or HCO3(-). The toxicity at high copper concentrations is limited by precipitation of malachite. (Author's abstract)
W90-02245

ENCLOSURE EXPERIMENTS IN FOOD-WEB MANIPULATION: FIRST STEP--DIVIDING THE EXPERIMENTAL LAKE.
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 2H.
W90-02255

INVESTIGATIONS OF BIOLOGICAL MEASURES FOR RESTORATION OF OIL POLLUTED TIDAL FLATS (UNTERSUCHUNGEN MIT DEM ZIEL DES VORSCHLAGS BIOLOGISCHER MASSNAHMEN BEI OELVERSCHMUTZUNGEN DER WATTOBERFLAECHE).
Oldenburg Univ. (Germany, F.R.). Inst. fuer Chemie und Biologie des Meeres.
T. Hoepner.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B88-81918/GAR. Price codes: E14 in paper copy, A01 in microfiche. Contract BMFT 01 ZV 85070, December 1987. 157p, 48 fig, 4 tab, 49 ref. English summary.

Descriptors: *Cleanup operations, *Oil pollution, *Biodegradation, *Tidal flats, *Hydrocarbons, Aerobic treatment, Anaerobic treatment, Nutrients, Algal cultures, Diatoms, Hexadecane, Cetyl alcohol, Palmitic acid, Naphthol, Carbon tetrachloride.

Biochemical aspects of hydrocarbon biodegradation in aerobic and anaerobic intertidal sediments were investigated. In laboratory experiments using standardized and inoculated mud and sandy sediments, the aerobic degradation rate of hexadecane, cetyl alcohol, palmitic acid and naphthalene was measured as well as the anaerobic denitrifying degradation of cetyl alcohol, palmitic acid and naphthol. As expected, no anaerobic hexadecane degradation was observed, but an oxygen dependent denitrifying naphthalene degradation could not be excluded. The degradation was dependent on nutrients. During degradation nutrients were fixed, resulting a decrease of degradation rate. Unialgal and axenic cultures of diatoms did not degrade hydrocarbons at a rate sufficient to be of ecological interest. A counting method for oil degrading bacteria was developed based on oil removeal by carbon tetrachloride followed by cell-counting in a counting chamber. From the results, which include field and oil-spill experiences, recommendations are drawn for restoration procedures for polluted intertidal flats by provision with oxygen and nutrients. (Author's abstract)
W90-02281

SUPERFUND RECORD OF DECISION: FRONTIER HARD CHROME, WA.
Environmental Protection Agency, Washington, DC. Office of Emergency and Remedial Response.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128409. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/ROD/R10-88/012, December 1987. 163p, 8 fig, 3 tab, 2 append.

Descriptors: *Industrial wastewater, *Cleanup operations, *Water pollution sources, *Metal-finishing wastes, *Groundwater pollution, Washington, Chromium, Heavy metals, Costs, Soil contamination, Wastewater disposal, Chemical treatment, Superfund.

The Frontier Hard Chrome (FHC) site covering approximately one-half acre, is located in the City of Vancouver, Washington. Underlying groundwater is used as the drinking water supply for the City of Vancouver. Two well fields are within one mile of the FHC site. The site has primarily been occupied by two businesses engaged in the chrome plating industry. Pioneer Plating operated at the site from 1958 to 1970. The site was then occupied by FHC until 1983. During Pioneer's operation and FHC's initial operation, chromium plating wastes were discharged into the sanitary sewer system. In 1975, the City of Vancouver determined that chromium in FHC's wastewater was upsetting the operation of its new secondary treatment system. FHC was directed to cease discharge to the sewer system until a treatment system was installed to remove chromium from their waste. At that time, FHC began discharge of their untreated plating wastes to a drywell behind the facility. In 1976, FHC was given a wastewater disposal permit for discharge to the drywell; the permit also contained a schedule for completion of a treatment system for their wastes. In 1982, FHC was found in violation of the Dangerous Waste Act for the illegal disposal for hazardous wastes, and was ordered to stop discharge of chromium plating wastes to the drywell. Chromium was discovered in the groundwater at more than twice the drinking water standards, and in soil and FHC building structures. The selected remedial action for this site includes: excavation of 7,400 cu yd of chromium contaminated soils exceeding 550 mg/kg with onsite treatment using chemical stabilization followed by onsite disposal of treatment residuals and placement of a final site cover; and demolition of the FHC building. The estimated present worth cost for this remedial action is $2 million. (Author's abstract)
W90-02289

DREDGING OPERATIONS TECHNICAL SUPPORT (DOTS) PROGRAM: AN UPDATE.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 6G.
W90-02294

RCRA FACILITY INVESTIGATION (RFI) GUIDANCE VOLUME I. DEVELOPMENT OF AN RFI WORK PLAN AND GENERAL CONSIDERATIONS FOR RCRA FACILITY INVESTIGATIONS.
Environmental Protection Agency, Washington, DC. Office of Solid Waste Management Programs.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128557. Price codes: A10 in paper copy, A01 in microfiche. Report No. OSWER Directive 9502.6C, July 1987. 267p, 16 fig, 17 tab, 18 ref, 2 append. EPA Contract EPA-S30/SW-87-001D.

Descriptors: *Waste disposal, *Hazardous wastes, *Water pollution control, *Legislation, Regulations, Site remediation, Project planning, Hazardous and Solid Waste Amendments.

On November 8, 1984, the US Congress enacted the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). Among the most significant provisions of HSWA are section 3004(u), which requires corrective action for releases of hazardous waste or constituents from solid waste management units at hazardous waste treatment, storage and disposal facilities seeking final RCRA permits; and section 3004(v), which compels corrective action for releases that have migrated beyond the facility property boundary. EPA will be promulgating rules to implement the corrective action provisions of HSWA, including requirements for release investigations and corrective measures. This guidance is divided into fifteen sections presented in four volumes. Volume I presents the procedures and rationale that should be used to develop a work plan for conducting the investigation, a general strategy for release investigations, several other aspects of the investigation and, the means by which the data collected during the RFI will be interpreted by the regulatory agency. (See also W90-02301) (Lantz-PTT)
W90-02300

RCRA FACILITY INVESTIGATION (RFI) GUIDANCE VOLUME IV. CASE STUDY EXAMPLES.
Environmental Protection Agency, Washington, DC. Office of Solid Waste Management Programs.

Available from the National Technical Information Service, Springfield, VA 22161, as PB89-128581. Price codes: A10 in paper copy, A01 in microfiche. Report No. OSWER Directive 9502.6C, July 1987. 218p, 55 fig, 27 tab. EPA Contract EPA-S30/SW-87-001D.

Descriptors: *Waste disposal, *Hazardous wastes, *Water pollution control, *Legislation, Regulations, Project planning, Hazardous and Solid Waste Amendments, Site remediation.

On November 8, 1984, the US Congress enacted the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). Among the most significant provisions of HSWA are section 3004(u), which requires corrective action for releases of hazardous waste or constituents from solid waste management units at hazardous waste treatment, storage and disposal facilities seeking final RCRA permits; and section 3004(v), which compels corrective action for releases that have migrated beyond the facility property boundary. EPA will be promulgating rules to implement the corrective action provisions of HSWA, including requirements for release investigations and corrective measures. Volume IV of the RCRA Facility Investigation (RFI) Guidance contains case studies selected to illustrate various concepts and procedures in Volumes I, II, and III. These case studies are provided to explain, through example, how various tasks can be conducted during RFIs. The case studies also identify some of the potential problems that can occur if the RFI sampling and analytical programs are not carefully designed and executed. These case studies, however, should not be used as the primary source of guidance forr RRFI program design and conduct. Instead, Volumes I, II and III should be consulted. The studies do not necessarily address details specific to individual facilities, and omission of certain RFI tasks should not be interpreted as an indication that such tasks are unnecessary or of less significance. Most of the case studies are based on actual sites. In some cases, existing data have been supplemented with hypothetical data to illustrate a particular point. (W90-02300) (Lantz-PTT)
W90-02301

FINANCING ALTERNATIVES FOR AGRICULTURAL NONPOINT SOURCE POLLUTION CONTROL PROGRAMS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
J. B. Braden, R. L. Farnsworth, W. D. Seitz, and D. L. Uchtmann.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-122253. Price codes: A06 in paper copy, A01 in microfiche. Report No. ILENR/RE-EA-88/20, October 1988. 124p, 1 fig, 29 tab, append. Illinois Department of Energy and Natural Resources Contract EA 48, Project 87/035.

Descriptors: *Financing, *Agricultural runoff, *Taxes, *Water pollution control, *Nonpoint pollution sources, Legal aspects, Economic aspects, Local governments, State governments.

Mechanisms for increasing state and local spending for abatement of nonpoint source pollution from agriculture were examined with emphasis on the legal feasibility and economic consequences of various funding options. The state and local funding mechanisms considered include income or sales taxes, an income tax checkoff, property taxes, special property assessments, water taxes, recreation license fees or surcharges, recreational equipment and fuel excise taxes, recreational access fees, erosion taxes, and farm chemicals taxes. Rated most highly are: property taxes or special assessments and water taxes at the local level; and water taxes and increased recreation fees at the state level. These mechanisms have a clear connection to the objective of improved water quality, would yield substantial revenues, and would be easy to administer. The remaining funding mechanisms would be too difficult to administer or have limited revenue potential. (Author's abstract)
W90-02302

MULTISPECTRAL REMOTE SENSING AS A FRESHWATER QUALITY SURVEILLANCE TOOL.
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
For primary bibliographic entry see Field 7B.
W90-02303

GROUND WATER MONITORING EVALUATION, HUGHES AIRCRAFT, U.S. AIR FORCE PLANT NO. 44, TUCSON, ARIZONA.
Environmental Protection Agency, Seattle, WA. Region X.
For primary bibliographic entry see Field 5A.
W90-02307

EFFECTS OF AGRICULTURAL WATER TABLE MANAGEMENT ON DRAINAGE WATER QUALITY.
North Carolina State Univ., Raleigh. Dept. of Biological and Agricultural Engineering.
R. O. Evans, J. W. Gilliam, and R. W. Skaggs.
University of North Carolina Water Resources Research Institute Report No. 237, March 1989. 87p, 60 fig, 7 tab, 24 ref, 4 append. Water Resources Research Institute Project 70056/70081.

Descriptors: *Agricultural watersheds, *Water quality control, *Drainage water, Nitrates, *Water pollution prevention, *Agricultural runoff, Nitrogen compounds, Nutrients, Phosphorus, Drainage effects.

The influence of controlled drainage, subirrigation and conventional drainage on drainage water quality, was investigated at five field locations in North Carolina. Drainage simulations using the water management simulation model, DRAINMOD, were also used to evaluate water management alternatives that were not implemented at each site for field evaluation. Drainage control was effective in reducing drainage outflow and the potential transport of nutrients to receiving surface waters. The control structures reduced drainage outflow at the field edge by approximately 40% as compared to conventional draiage practices. Drainage control had very little influence on nutrient concentrations in drainage outflow. Nitrate concentrations at the field edge tended to be slighly higher and total kjeldahl nitrogen (TKN) and total phosphorus (TP) concentrations slightly lower for good subsurface drainage compared to surface drainage alternatives. Variation in nitrate concentrations was observed among sites, but this also appeared to be related to the relative intensity of subsurface drainage present. The dominant factor influencing total nutrient transport was the amount that drainage outflow was reduced by controlled drainage practices. The reduction in nutrient transport was nearly proportional to the reduction in drainage outflow. Controlled drainage reduced the annual transport of total nitrogen (NO3 and TKN) by 7 kg/ha (46.5%) and total phosphorus by 0.19 kg/ha (44%). Considering that nearly 1 million hectares of cropland in North Carolina are artificially drained, this represents a potential reduction at the field's edge of nearly 7,000 metric tons N and 190 metric tons P annually. The reduction of N and P to streams and estuaries if all improved drainage systems used controlled drainage would be less than observed at the field edge in this study, but still significant. (Lantz-PTT)
W90-02311

EUROPEAN COMMUNITY ACTIVITIES TOWARDS THE PROTECTION OF THE MARINE ENVIRONMENT.
Commission of the European Communities, Brussels (Belgium). Protection and Management of Water.
V. Mandl.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 5-13, 3 fig, 8 ref.

Descriptors: *Wastewater disposal, *Europe, *Water pollution control, *Marine environment, *Environmental protection, Water quality control, Hazardous wastes, Legislation, Ocean dumping, Oil pollution, Information exchange, International agreements.

Measures which have been taken by the European Community to control and reduce pollution of marine waters include: directives on bathing water quality, shellfish waters, pollution by dangerous substances, exchange of information, and a proposal on dumping at sea. Measures to reduce marine pollution have centered on six priority areas: (1) the protection of the sea against oil and chemical pollution; (2) data collection and exchange of information; (3) measures specific to certain branches of industry; (4) activities under international agreements and organizations; (5) the definition of quality objectives; and (6) the protection from dangerous substances. Participation in discussions and initiatives with other international organizations is considered an important part of protection of the marine environment. (See also W90-02317) (Lantz-PTT)
W90-02318

LEGISLATION AND FUTURE DEVELOPMENTS IN THE MARINE DISPOSAL OF SEWAGE AND SLUDGE IN THE USA.
Environmental Protection Agency, Washington, DC. Office of Marine and Estuarine Protection.
T. T. Davies.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988. p 15-27.

Descriptors: *Wastewater disposal, *Ocean dumping, *Sludge disposal, *Legislation, *Water pollution effects, *Coastal waters, Great Lakes, Estuaries, Regulations, Eutrophication, Environmental effects, Fish, Shellfish.

The history, status, and prognosis for marine disposal of sewage and sludge in the United States is described from a regulatory and environmental protection perspective, by focusing geographically on the near coastal waters (NCW) of the United States. The NCW include the Great Lakes (Lakes Superior, Huron, Michigan, Erie, and Ontario), estuaries, and shallow coastal waters out to the 12 mile, contiguous zone limit. It is EPA's policy: (1) to protect the oceans from significant adverse effects of waste disposal; (2) to allow ocean disposal of publicly operated treatment works (POTW) sludges only when there are no practicable, land-based alternatives that have less impact on the total environment; and (3) over the long run, to encourage environmentally beneficial approaches to POTW sludge management, also, minimization and recycling of other wastes. EPA has documented evidence of five kinds of major problems: (1) widespread toxic contamination of fish and shellfish; (2) eutrophic conditions and hypoxia over thousands of hectares of coastal waters; (3) widespread pathogenic contamination of fish and shellfish as well as thousands of reported cases of gastrointestinal infections of persons consuming pathogen-contaminated fish and shellfish; (4) loss of, or adverse changes to, thousands of hectares of essential marine habitat each year and at increasing rates of loss; and (5) loss of living marine resources, such as substantial declines in recreational and commercial fisheries, as well as threatened and endangered birds and mammals. EPA fully recognizes that adequate protection of human health and the marine environment will require continued strict enforcement of existing regulatory authorities over ocean disposal of sewage and sludge, as well as ocean disposal of all other waste materials. (See also W90-02317) (Lantz-PTT)
W90-02319

LEGAL AND SCIENTIFIC CONSTRAINTS.
Anglian Water Authority, Norwich (England). Norwich Sewage Div.
P. J. Matthews.
IN: Marine Treatment of Sewage and Sludge. Proceedings of the Conference Organized by the Institution of Civil Engineers and held in Brighton on 29-30 April 1989. Thomas Telford, London. 1988.

p 29-44, 22 ref.

Descriptors: *Coastal waters, *Wastewater disposal, *Sludge disposal, *Legislation, *Management planning, Legal aspects, Great Britain, Licensing, Fines, Permits, Monitoring, Environmental protection, Ocean dumping, Wastewater outfall.

The treatment of sewage and sewage sludge in the sea must be conducted in accordance with external environmental legislation. To do so, and in order to avoid any deleterious public health or environmental effects and to make the best use of available financial resources, careful planning control and surveillance is required. The practices and problems of a technical manager in an English water authority in meeting those responsibilities are described. In Great Britain, the legal constraints are addressed through three legislative acts: (1) The Water Act of 1973; (2) the Control of Pollution Act of 1974; and (3) the Food and Environment Protection Act of 1985. These acts address water quality management and dispersal of wastes at sea through the licensing of permits, standards for pollutant limits, and the levying of fines. Licenses are required for disposal of waste at sea, for marine construction workers, such as outfalls, and for tracer chemicals. The requirements of environmental protection and sound economics are reconciled by using the 'Best Practicable Environmental Option'. Each available option is costed and the cheapest is selected as the favored. Planning and operation of discharge facilities requires analysis of the physical locations, proper design of diffusers at the discharge points, proper treatment of the wastewater, and monitoring of the bacterial quality of the coastal waters. (See also W90-02317) (Lantz-PTT)
W90-02320

COASTAL POLLUTION--AESTHETICS AND/OR HEALTH.
Coastal Antipollution League, Ltd.
For primary bibliographic entry see Field 5C.
W90-02321

SEA OUTFALLS FOR INDUSTRIAL AND URBAN EFFLUENT--FRENCH PRACTICE.
Societe Grenobloise d'Etudes et d'Applications Hydrauliques (France). Applied Mathematics Dept.
For primary bibliographic entry see Field 5E.
W90-02322

MARINE DISPOSAL OF SEWAGE AND SLUDGE--AUSTRALIAN PRACTICE.
Metropolitan Water, Sewerage and Drainage Board, Sydney (Australia).
For primary bibliographic entry see Field 5E.
W90-02323

OIL DISPERSANTS: NEW ECOLOGICAL APPROACHES.
STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. 302p. Edited by L. Michael Flaherty.

Descriptors: *Dispersants, *Oil dispersants, *Cleanup operations, *Water pollution treatment, *Oil spills, Oil pollution, Symposium, Ecological effects, Emulsifiers, Chemical treatment.

The American Society for Testing and Materials (ASTM) Committee F-20 on Hazardous Substances and Oil Spill Response sponsored a state-of-the-art review of 'Dispersants: New Ecological Approach through the 90's' at its symposium held in Williamsburg, VA, 12-14 Oct. 1987. Over 145 people from 7 countries attended to learn of the latest technological advances in spill countermeasures. Several papers in this book discuss modern computer usages to assist response application while another paper describes using a computer for both training and contingency planning. Other papers deal with the crisis in response training, while another makes an indepth analysis of the behavior of dispersed and nondispersed fuels in sewer systems. The papers assembled in this book break new ground in many innovative areas of chemical countermeasures, specifically gelling agents, emulsifiers, and elasticizers or viscoelastic enhancing agents. (See W90-02335 thru W90-02357) (Lantz-PTT)
W90-02334

EFFECTS OF CHEMICAL DISPERSANT AGENTS ON THE BEHAVIOR AND RETENTION OF SPILLED CRUDE OIL IN A SIMULATED STREAMBED CHANNEL.
Science Applications International Corp., San Diego, CA.
J. R. Clayton, G. H. Farmer, J. R. Payne, G. D. McNabb, and P. C. Harkins.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 4-24, 7 fig, 3 tab, 17 ref. EPA Contract 68-03-3113.

Descriptors: *Oil dispersants, *Dispersants, *Oil spills, *Cleanup operations, *Water pollution treatment, Oil pollution, Simulation analysis, Model studies, Chemical treatment, Field tests, Oil, Alaska, Oil-water interfaces, Environmental effects.

Field experiments were performed to obtain first-step estimates of the effects of selected chemical dispersant agents (OFC D-609 an Corexit 9550) on the behavior and retention of spilled crude oil in a shallow freshwater streambed environment in southcentral Alaska. Comparisons between experiments with and without pre-spill additions of dispersants to the oil included measurements of oil in sediment and water samples. Sediment and water contamination by oil was quantified by flame ionization detector capillary gas chromatography (FID-GC) as well as visual observations in the simulated streambed channel following the spill events. Inclusion of dispersants in the oil produced the intended result of enhancing dispersion of oil into the aqueous phase. However, distributions of oil in aqueous and sediment samples were controlled by interactions between a variety of factors including rheological properties of the oil (for example, oil/water interfacial surface tension values), particle size distributions of sediment matrices, exposure of sediment surfaces to oil, and in situ water flow characteristics at specific streambed channel sites. The results imply that use of chemical dispersants to mitigate effects of oil spills in freshwater streambed environments must include an understanding of the interplay between variables related to both the type of oil released and the specific streambed environment. (See also W90-02334) (Author's abstract)
W90-02335

DISPERSANT USE GUIDELINES FOR FRESHWATER AND OTHER INLAND ENVIRONMENTS.
Environmental Protection Agency, Washington, DC.
L. M. Flaherty, W. B. Katz, and S. Kaufmann.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 25-30, 6 fig, 3 tab, 4 ref.

Descriptors: *Oil dispersants, *Dispersants, *Water pollution treatment, *Standards, *Cleanup operations, Oil spills, Permafrost, Soil porosity, Cold regions, Rivers, Streams, Ponds, Lakes, Swamps.

Work in progress by the American Society for Testing and Materials Subcommittee F20.13 on Treatment on a series of guidelines covering the use of dispersants in nonsaline environments is presented. These environments include freshwater ponds, lakes, and streams, as well as land. The guidelines are to be patterned after those produced by an earlier task group of the same committee covering saline environments. Discussions over a long period of time developed an outline of those environments where the use of dispersants might be considered: (I) No surface water--(a) over permafrost, (b) over porous ground, and (c) over nonporous ground; (II) Permanent surface water--(a) moving water (rivers, creeks and large lakes), and (b) non-moving water (swamps, small lakes, and ponds); and (III) Nonpermanent surface waters. It was apparent almost immediately that any experimental work actually done or being considered was confined to arctic and near-arctic areas. Use of dispersants on inland water or land, or in tropical areas, has had almost no consideration at all. The environments listed may be augmented in the future if discussion and thought indicate it would be desirable. (See also W90-02334) (Lantz-PTT)
W90-02336

DISPERSANTS IN THE FRESHWATER ENVIRONMENT.
Esso Resources Canada Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 5C.
W90-02337

ECONOMIC EVALUATION OF DISPERSANTS TO COMBAT OIL SPILLS.
Texaco, Inc., Beacon, NY.
A. H. Lasday.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 41-48, 3 fig, 3 tab, 3 ref.

Descriptors: *Oil dispersants, *Dispersants, *Water pollution treatment, *Oil spills, *Cleanup operations, Chemical treatment, Costs, Economic aspects.

Chemical dispersants for combatting oil spills increasingly are being recognized as a most valuable addition to the available means for damage prevention and cleanup. A study of oil spill cleanup costs enables one to apply a most useful perspective to the issue of costs. Based on public information sources where costs were reported for cleanup of oil that impacted a shoreline, mechanical methods ranged in cost from a minimum of $65/barrel of oil to a maximum of $5000/barrel. In contrast, costs for intercepting the oil at sea by spraying dispersant from four-engine fixed wing aircraft ranged between a minimum of $15/barrel of oil treated up to a maximum of $60/barrel of oil treated. The study spill sizes were 10,000 to 100,000 barrels of oil. (See also W90-02334) (Author's abstract)
W90-02338

USE OF CHEMICAL DISPERSANTS TO CONTROL OIL SPILLS IN SHALLOW NEARSHORE WATERS.
McAuliffe (Clayton) and Associates, Fullerton, CA.
C. D. McAuliffe.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 49-72, 2 fig, 6 tab, 69 ref.

Descriptors: *Oil dispersants, *Chemical treatment, *Dispersants, *Oil spills, *Cleanup operations, *Ecological effects, *Water pollution treatment, Shallow water, Salmon, Mangrove swamps, Herring, Oil pollution.

Oil slicks should be dispersed in shallow nearshore waters to prevent oil from stranding. Field and laboratory studies show that chemically dispersed oil causes fewer adverse biological effects, and those are transitory. Spilled oil attains an average thickness of 0.1 mm or less in an hour or two on the water surface. Therefore, the maximum concentrations in water are 100 parts per million (ppm) at 1 m and 10 ppm at 10 m. Most volatile/soluble hydrocarbons that cause toxicity evaporate from the slick in a few hours. Soluble hydrocarbons under field slicks and in chemically dispersed oil plumes are generally a factor of 150 to 1 million lower than those found to cause mortality of a wide range of organisms in laboratory studies. Chemical dispersants appear to protect some organisms, apparently by reducing oil droplet 'stickiness.' A relatively few mechanically dispersed crude oil droplets, compared to many chemically dispersed droplets, caused: (1) increased larval abnormalities in herring egg exposures, and (2) increased petroleum content in adult coho salmon tissue. Chemical dispersion of crude oil prevented:

(1) mortality of mature mangrove trees in Panama, and (2) adverse effects on intertidal organisms in Maine and immediate subtidal organisms in the Arctic. An oil spill is large or small relative to the receiving water. Scenarios of large and small spills show that there are no environmental reasons for not using chemical dispersants. A review of control capabilities shows that spills exceeding 160 cu m (1000 billion barrels/day) can only be accomplished by multi-engine aircraft spraying dispersant, with mechanical methods assisting in critical areas. This assumes that the oil is dispersible. If not, most oil from spills over 160 cu m/day may strand on shores. To be most effective, dispersant spraying must be initiated early, meaning that preapproval is necessary. Reduced adverse environmental effects along with greater control capabilities indicate that chemical dispersants should be used even in shallow nearshore waters. (See also W90-02334) Author's abstract)
W90-02339

FIELD EXPERIENCE WITH DISPERSANTS FOR OIL SPILLS ON LAND.
Petro-Green, Inc., Dallas, TX.
A. Paddock.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 73-77.

Descriptors: *Water pollution treatment, *Oil dispersants, *Dispersants, *Oil pollution, *Oil spills, *Cleanup operations, *Soil contamination, Path of pollutants, Water pollution sources, Biodegradation.

When oil spills onto coastal water of the United States or leaks reach the inland waters, an elaborate set of U.S. federal and state regulations comes into effect under the National Contingency Plan (NCP). Ironically, when an oil discharge is confined to land alone, very few regulations exist. Although spills on land are quite frequent, they do not arouse the news media or even local regulators, and the oil is often left in place. Dispersants, up to now not widely used, offer an economical and environmentally preferred option compared to other actions that might be taken. Although the use of dispersants for oil spills on land has never been regulated under the NCP, spillers have been reluctant to use them on land as a result of the possible rainfall runoff into controlled waters. Under the NCP (Subpart H) revised as of 20 Nov. 1985, the attributes of a dispersant on land can now be considered along with the existing techniques of burning, plowing under, or hauling away. Dispersants specifically formulated for use on contaminated soil have been on the market for over ten years. The first criterion for such a dispersant is that it must be compatible and effective with freshwater. Many of the most common dispersants on the market are for use on saltwater only. Other dispersant characteristics to be considered are emulsion stability and rapid biodegradability. Results of actual field experience on a wide variety of soil types, land uses, and topographies indicate that dispersant use on land can be effective. (See also W90-02334) (Author's abstract)
W90-02340

EFFECT OF ELASTOMERS ON THE EFFICIENCY OF OIL SPILL DISPERSANTS.
American Univ., Washington, DC. Dept. of Chemistry.
P. F. Waters, A. F. Hadermann, and L. Lambrecht.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 78-83, 6 fig, 4 ref.

Descriptors: *Oil dispersants, *Dispersants, *Water pollution treatment, *Elastomers, *Oil spills, *Cleanup operations, Chemical treatment.

Low concentrations of high molecular weight elastomers limit the spread of oil on the high seas, even in storm-driven waves of 2 to 3 m. By contrast, dispersants break up oil films and distribute the oil in the subsurface water. If the spreading of a newly spilled oil slick can be curtailed, it could, provided there were no antisynergism, be dispersed with less dispersant than might otherwise be required, because the elastomer-treated slick would cover less areas. The results show that ultrahigh molecular weight polyisobutylene (PIB) exhibits remarkable viscoelasticity in hydrocarbon liquids. This property significantly impedes the spreading of oil on water surfaces. It was anticipated that this property of the polymer might forstall the ability of dispersants to disseminate oil spilled on the high seas if both were used simultaneously. The results obtained here demonstrate that whereas the PIB does indeed retard the dispersability of the oils to some extent, at concentrations of polymer sufficient to impede the spread of oil, treatment with an oil soluble dispersant still promoted dispersion. (See also W90-02334) (Lantz-PTT)
W90-02341

USE OF A COMPUTERIZED SPILL RESPONSE TOOL FOR EMERGENCY RESPONSE, PERSONNEL TRAINING, AND CONTINGENCY PLANNING.
L. M. Flaherty, A. G. Hansen, and A. Dalsimer.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 84-90, 1 fig, 17 ref.

Descriptors: *Water pollution treatment, *Oil dispersants, *Dispersants, *Oil spills, *Alternative planning, *Cleanup operations, Training, Management planning, Computer programs, Decision making.

Under the aegis of the US EPA, a computerized decision tree (CDT) was developed in 1984 to assist On-Scene Coordinators (OSCs) in the decision making process during an oil spill incident. Since that time, the CDT has been expanded and refined for use not only in real-time spill response, but for personnel training and contingency planning. The CDT has been distributed to EPA Regions, US Coast Guard Districts, and other spill response officials in the United States and overseas. Its widespread acceptance, however, has been somewhat hampered by a lack of understanding of its maximum use beyond immediate spill response activities. Enhancements that have been made to the CDT during the past three years, and its potential for applications in personnel training in both emergency situations and for contingency planning include: (1) a computerized decision tree; (2) detailed data on new products; and (3) data on toxicity and effectivness of products. Possible extensions of the CDT to hazardous materials incidents is also explored, along with other future plans for the CDT as a powerful tool in combatting environmental damage. (See also W90-02334) (Author's abstract)
W90-02342

CRISIS IN RESPONSE TRAINING.
Sunshine Technology Corp., West Hartford, CT.
S. Kaufmann.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 91-97, 6 fig, 7 ref.

Descriptors: *Oil dispersants, *Dispersants, *Training, *Cleanup operations, *Water pollution treatment, Chemical treatment, Oil spills, Alternative planning, Management planning.

The need for training of first responders, contractors, government agencies, and insurance companies to use chemical dispersants effectively is demonstrated by the loss of opportunities both to reduce cleanup costs and to gain helpful data in evaluating the advantages of using dispersants. As important as learning the legal basis for dispersant use, is the hands-on training whereby a trainee assists in: (1) layout of the training area; (2) creation of a training 'spill'; (3) detection and measurement of spills; (4) demonstration of physical equipment (booms, skimmers, sorbents); (5) types of dispersant application equipment (small fuel spill sprayer, eductors, Warren Springs gear, Hovercraft, and helicopters and fixed wing aircraft); (6) types of chemical countermeasures (dispersants, surface collecting agents, viscoelasticity enhancing agents); (7) hands-on involvement of trainees (with: dispersing boomed slick with eductor, spraying slick in training tank with fuel spill sprayer, and learning appearance of dispersed oil); and (8) polishing of the spill area following the drill, using dispersant, sorbent, and boom cleanup and recovery. This interest in a new method of training in the use of chemical countermeasures emphasizes the need to be prepared to use them on actual spills as they occur. (See also W90-02334) (Lantz-PTT)
W90-02343

COMPUTER-ASSISTED PLANNING SYSTEM FOR OIL SPILL RESPONSE CHEMICAL APPLICATIONS.
Alaska Clean Seas, Anchorage.
R. V. Shafer.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 98-103, 1 fig, 1 tab, 3 ref.

Descriptors: *Water pollution treatment, *Oil dispersants, *Dispersants, *Computer programs, Alternative planning, *Oil spills, *Cleanup operations, Chemical treatment, Management planning, Computer-Assisted Dispersant Application.

The microcomputer is a very useful oil spill response tool: It can help the spill contingency planner organize and present a wide variety of information; it can help the spill response trainer create realistic scenarios and models of spill events; and it can help the spill response operations manager optimize operational decisions and expedite a variety of communications. Microcomputers can help plan for and respond to oil spills, through: trajectory modeling, inventories, spill reporting, response decision making, and records and communications. CADA, a program for Computer-Assisted Dispersant Application, helps expedite operational decisions and optimize operations for the chemical dispersion of spilled oil in Alaskan waters. The various steps in the program are: (1) Select next nearest base (Alaskan location for logistics support for spill response operations); (2) Select next dispersant delivery vehicle set and determine time to deploy it to the base; (3) Select next suitable dispersant and determine dispersant-to-oil ratio (DOR) dose rate; (4) Check dispersant suitability with oil and determined DOR dose rate; (5) Dosage rate (dr) < 20 gal/acre; (6) Calculate real application rate, number of passes required to achieve the required rate with the selected equipment, and the total time for the mission; (7) Print; (8) Save data on best run; (9) Last dispersant; (10) Last vehicle; (11) Last base; (12) Print advisory notes; and (13) Print data on solution with best time. (See also W90-02334) (Lantz-PTT)
W90-02344

APPROACHES TO PLANNING FOR DISPERSANT USE IN OIL SPILL RESPONSE.
Environmental Sciences, Los Angeles, CA.
J. Lindstedt-Siva.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 104-113, 2 fig, 1 tab, 25 ref.

Descriptors: *Oil dispersants, *Alternative planning, *Dispersants, *Oil spills, *Water pollution treatment, *Cleanup operations, Decision making, Management planning, Environmental effects.

Using dispersants to control oil spills has been highly controversial since the 1967 Torrey Canyon spill. Since that time many spill responders have viewed dispersants only as a 'last resort' option. Dispersant use is most effective in the early stages of an oil spill, yet most response plans call for dispersant use decisions to be made only after a spill occurs. These decisions require, at a minimum, hours, and may require days. Recently, there have been efforts to shorten this decision making process. A multidisciplinary, multi-agency task force under the auspices of the American Society for Testing and Materials (ASTM) developed ecologically based guidelines for dispersant use in marine environments. The guidelines for 13 different marine and coastal habitat types consider dis-

persant use both to protect and to clean the habitat. They also identify those habitats that are the highest priority to receive protection in the event of a spill. The other project was developed by an American Petroleum Institute (API) task force and contractor with input from federal and state government agencies. It is a site-specific method for planning in advance where to use or not use dispersants in a marine environment. It involves dividing an offshore region into 'dispersant use zones' based on ecological considerations. This method was applied to selected areas offshore southern California as a test. Based on wind and current data, it was determined that oil spilled anywhere offshore in this study area, under normal conditions, might eventually reach sensitive resources. Therefore, all offshore areas have been designated as Zone 1 (Dispersant Use Recommended). Several coastal and some offshore regions have been designated Zone 3 (Dispersant Use Conditional) because of limited water exchange and proximity to sensitive resources. Areas further offshore (that is, off the chart) would be classified Zone 2 (Dispersant Use Acceptable) since oil in this zone is unlikely to contact sensitive resources. (See also W90-02334) (Author's abstract)
W90-02345

PLANNING FOR DISPERSANT USE.
Shell Oil Co., Houston, TX.
J. P. Fraser.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 114-134, 4 fig, 5 tab, 25 ref, 2 append.

Descriptors: *Oil dispersants, *Dispersants, *Management planning, *Cleanup operations, *Water pollution treatment, Oil spills, Decision making, Alternative planning, Standards, Regulations.

Although the National Contingency Plan states that the Federal On-Scene Coordinator (OSC) may authorize the use of dispersants on an oil spill, such authorization is not automatic. In practice, the applicant for permission to use dispersants must submit a plan which then will be considered by the OSC and others involved in the approval process. This plan generally must indicate not only that dispersant use is desirable as a means of mitigating the spill but also must show why use would result in lower environmental impact than if dispersants were not used. The components of a dispersant use plan should include the following: (1) Spill specific information such as how much of what oil was spilled, when did it occur, wind and sea conditions, and expected oil spill trajectories; (2) Information on resources available for dispersant application such as dispersant stockpiles that may be used, properties of these dispersants, application equipment, and information on application and monitoring methods; (3) Information on environmental impacts, including the comparative impacts of dispersed oil versus untreated oil; (4) A guide or system for decision making which shows how the above information is used in developing the on-scene decision for or against dispersant use. The decision making system should be agreed upon well in advance of any spill; and (5) Recommendations regarding dispersant use on the specific spill incident and justification for the recommendations. Use of this planning method will expedite decision making at the time of a spill, will lead to more rational and logical dispersant use decisions, and will enable the decision maker to document his decision. (See also W90-02334) (Lantz-PTT)
W90-02346

DISPERSANT USE CONSIDERATIONS.
Coast Guard, Washington, DC. Pollution Response Branch.
M. L. Lavache.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 135-143, 2 fig, 1 ref.

Descriptors: *Oil dispersants, *Governmental interrelations, *Dispersants, *Water pollution treatment, *Cleanup operations, *Decision making, Standards, Interagency cooperation, Oil spills, Management planning.

The development of dispersant use guidelines and decision making criteria are complex interagency activities. The use of dispersants as an oil spill response option in United States' water occurs as the result of a decision process established by the National Contingency Plan (NCP), a federal regulation. The NCP requires a recommendation from the federal predesignated On-Scene Coordinator (OSC) to the US EPA representative to the Regional Response Team (RRT). The recommendation is simultaneously made to the State RRT representative(s) whenever state(s') waters are affected. The approval necessary for dispersant use is concurrence with the OSC's recommendation by the EPA RRT representative and, as appropriate, the State RRT representative(s). The US Department of Commerce (DOC) and the Interior (DOI) have related authorities and are also RRT member agencies. The NCP recommends that EPA and state RRT representatives consult with their DOC and DOI counterparts, as appropriate, during the decision process. Such consultation may become mandatory following a pending revision of the NCP, and where federal trusteeship interests are involved. Factors that influence the decision to use dispersants are: (1) the availability of an adequate supply, personnel, and equipment; (2) An acceptable monitoring plan; and (3) Training opportunities to serve the needs of the parties involved in the planning and applications process. (See also W90-02334) (Author's abstract)
W90-02347

OIL DISPERSANT GUIDELINES: ALASKA.
National Ocean Service, Rockville, MD.
C.-A. Manen, P. S. O'Brien, B. Hahn, H. Metsker, and L. B. Fox.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 144-151, 3 fig, 6 ref.

Descriptors: *Water pollution treatment, *Oil dispersants, *Dispersants, *Cleanup operations, *Alaska, *Oil spills, Alaska, Marine environment, Chemical treatment, Classification, Cook Inlet, Alaska Regional Response Team.

The Alaska Regional Response Team (RRT) is in the process of developing preconsultation and preapproval plans allowing for the limited use of dispersants on oil spills in Alaskan marine waters. 'General Alaska Dispersant Use Criteria' briefly reviews the present data for the use of dispersants in Alaskan coastal waters. This system is being applied to Alaskan areas in a site-specific and resource-specific manner. The general criteria and the application of the classification system to Cook Inlet have been subjected to public comment from the oil and fishing industry, approved by the RRT, subjected to public comment from the oil and fishing industry, approved by the RRT, and incorporated into the Alaska Regional Contingency Plan. At present, this classification system is being used to develop dispersant use guidelines for Prince William Sound, a much different regime, both physically and biologically, from Cook Inlet. (See also W90-02334) (Author's abstract)
W90-02348

LETTERS OF AGREEMENT FOR THE USE OF DISPERSANTS.
Coast Guard District (7th), Miami, FL. Marine Environmental Protection Branch.
T. E. Hart.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 152-156.

Descriptors: *Water pollution treatment, *Oil dispersants, *Regulations, *Dispersants, *Cleanup operations, *Oil spills, Alternative planning, Governmental interrelations, Interagency cooperation, Management planning.

Subpart H to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) authorizes the On-Scene Coordinator (OSC) to use dispersants on oil discharges if certain conditions have been met. Primary among these is the requirement that the US EPA representative to the Regional Response Team (RRT) and the affected state concur regarding dispersant use. However, obtaining concurrence after a spill can be so time-consuming that optimal dispersant use is no longer possible. Since the effectiveness of dispersants is time-critical, the sooner that concurrence can be obtained and the dispersant applied, the more effective such application should be. One way to expedite the decision making process is in agreements that pre-authorize the OSC to use dispersants. The NCP encourages RRTs to plan for such use and to have pre-authorizations in place. The Region IV RRT has developed an agreement for the use of dispersants in Florida. Two similar agreements have been developed by the Caribbean RRT for Puerto Rico and the US Virgin Islands. While none of these agreements allows the unrestricted use of dispersants, each specifies areas where the OSC can use dispersants and areas where dispersants cannot be used without further discussion with the EPA and the state. The Caribbean RRT has also included provisions in the agreements for a monitoring strategy to assess the effectiveness of dispersants when they are used. The key to an effective and successful response is having an organization and contingency plan in place. Such arrangements are an integral part of the Region IV and Caribbean RRTs' contingency plans and will result in a more timely and informed decision on whether dispersants will be used. (See also W90-02334) (Author's abstract)
W90-02349

FIELD MEASUREMENT OF EFFECTIVENESS: HISTORICAL REVIEW AND EXAMINATION OF ANALYTICAL METHODS.
Environment Canada, Ottawa (Ontario). Environmental Emergencies Technology Div.
M. F. Fingas.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 157-178, 7 fig, 3 tab, 44 ref.

Descriptors: *Oil dispersants, *Dispersants, *Field tests, *Water pollution treatment, *Oil spills, *Cleanup operations, History, Oil pollution, Evaluation, Statistical analysis.

Data are provided on 106 separate offshore experimental spills to determine dispersant field effectiveness. Effectiveness ratings for 25 of these spills were assigned by the experimenters; they vary from 0 to 100% and have an average of 33%. Measurement techniques used for these experiments include: subsurface measurements to determine oil in the water column, surface sampling to determine oil remaining, dispersant application amount or distribution, and the use of remote sensing to observe visually the results or to quantify the area of surface oil. Existing means of detection and quantification appear to be effective. The mathematical relationships used to provide the integrated amount of oil in the water column are also examined. It is shown by simulation that effectiveness claimed is highly sensitive to both assumptions and mathematical treatment. Historical data are used to show that effectiveness values can vary over an order of magnitude depending on the algorithm used. A number of phenomena have been observed at spill sites. Herding of oil occurs immediately after dispersant application and has sometimes been misinterpreted as dispersion. Examinations of spills where slicks were monitored for longer than 3 hr show that extensive resurfacing of oil occurred. Resurfacing is particularly problematic because, depending on current and wind, resurfacing may occur outside slick boundaries. When this occurs, resurfaced oil is not included in subsequent calculations, and consequently, effectiveness is overestimated. Field effectiveness cannot be reliably determined by using only measurements of oil in the water column. The distribution of oil in the water column is not known nor does it necessarily bear a relationship to surface slick boundaries. Furthermore, in the initial hours--perhaps as many as 7--the oil concentration in the water column may be transitory as signifi-

cant amounts of oil resurface. Remote sensing over a long-term such as two or three days is suggested as the primary technique for monitoring experimental spills and for attempting to establish a mass balance. (See also W90-02334) (Lantz-PTT)
W90-02350

NEW PAIR OF EYES II: LOOKING AT DISPERSANTS FROM A DIFFERENT POINT OF VIEW.
Illinois Chemical Corp., Highland Park, IL.
W. B. Katz.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 179-193, 11 fig, 4 tab, 12 ref.

Descriptors: *Oil dispersants, *Dispersants, *Cleanup operations, *Oil spills, *Water pollution treatment, Chemical treatment, Physical treatment.

Those concerned with managing oil spills have been struggling for the past 15 to 20 years to improve the application and effectiveness of dispersants. Progress has been slow and uneven, especially in the United States where the attitude of regulatory agencies has been to downplay the use of dispersants. A different approach to the problem of dispersing oil, using some new methods for dispersing oil spills includes: (1) low toxicity chemical agents; (2) mechanical energy sources--air cushion vehicle air streams, gas turbine exhaust, vertical take-off and landing aircraft exhaust, helicopter downdraft, air blowers, and homogenizers; (3) improved application equipment--large helicopters, hydrofoils, and submarines; (4) chemical treatment--in situ reactions and in situ additions; and (5) equipment cleaning. (See also W90-02334) (Lantz-PTT)
W90-02351

MEASUREMENTS ON NATURAL DISPERSION.
Waterloopkundig Lab. te Delft (Netherlands).
G. A. L. Delvigne.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 194-206, 9 fig, 13 ref.

Descriptors: *Oil dispersants, *Dispersants, *Water pollution treatment, *Path of pollutants, *Fate of pollutants, *Oil spills, Waves, Turbulent flow, Mathematical studies, Oil pollution, Salinity, Temperature.

In the case of an oil spill, knowledge is needed concerning the natural dispersion behavior of oil in a particular situation for decision making with respect to the application of chemical dispersants. Small-scale and full-scale laboratory measurements were performed on the natural dispersion rate Q, droplet size distribution d sub o(f), and intrusion depth z, for a surface oil slick broken up by breaking waves and the breakup of submerged oil (submerged spill) in a turbulent ambience. Empirical relations were derived for Q, d sub o(f), and z, as a function of oil type, weathering state, oil layer thickness, breaking wave energy, temperature, and water salinity. (See also W90-02334) (Author's abstract)
W90-02352

LABORATORY STUDIES ON OIL SPILL DISPERSANTS.
Environment Canada, Ottawa (Ontario). Environmental Emergencies Technology Div.
M. F. Fingas, V. M. Dufort, K. A. Hughes, M. A. Bobra, and L. V. Duggan.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 207-219, 44 fig, 8 tab, 23 ref, append.

Descriptors: *Oil spills, *Water pollution treatment, *Oil dispersants, *Dispersants, *Cleanup operations, Laboratory studies, Statistical analysis, Evaluation, Comparison studies, Laboratory equipment.

Laboratory tests of oil spill dispersant effectiveness are used around the world to select dispersants for application to specific oils. These tests are presumed, by some, to represent real sea conditions and to provide the user with a result that is representative if not identical to a real dispersant application at sea. At this time, the two most widely used tests are the Mackay test, and the Labofina test. The Mackay test employs a high velocity air stream to energize 6 L of water, whereas the Labofina test uses rotation of a separatory funnel with 250 mL of water. Both tests apply a large amount of energy to the oil/water system. Test results from these apparatuses with those from two lesser known devices, the oscillating hoop and the swirling flask were compared. Both devices are relatively new, and protocols for their use have not been finalized. The oscillating hoop apparatus uses a hoop which is moved up and down at the water surface. The concentric waves serve both to energize the oil in the hoop and to contain it. Thirty-five L of water are used in this test. The swirling flask test makes use of a 125-mL Erlenmeyer flask. The flask is rotated using a standard chemical/biological shaker to produce a swirling motion in the contents. A total of 121 oil/dispersant combinations were tested in the 4 apparatuses. The correlation of numeric values between the Mackay, Labofina, oscillating hoop, and swirling flask is low. The correlation of effectiveness ranking is also poor. Results show that all the high energy tests (the Mackay, the Labofina and the oscillating hoop) produce unique dispersant effectiveness results and those correlate poorly with the physical properties of the oil. (See also W90-02334) (Lantz-PTT)
W90-02353

DESIGN AND EVALUATION OF A LARGE BOAT-MOUNTED DISPERSANT SPRAYING SYSTEM AND ITS INTEGRATION WITH OTHER APPLICATION EQUIPMENT.
Clean Seas, Carpinteria, CA.
L. A. Onstad, and G. P. Lindblom.
IN: Oil Dispersants: New Ecological Approaches. STP 1018. American Society for Testing and Materials, Philadelphia, PA. 1989. p 220-228, 4 fig, 4 tab, 2 ref.

Descriptors: *Water pollution treatment, *Oil spills, *Oil dispersants, *Dispersants, *Mechanical equipment, *Cleanup operations, Evaluation, Performance evaluation, Spraying, Design standards.

Oil spill response groups have recognized that it is essential to have the ability to apply dispersants properly when they are needed. Some of these organizations have developed unique application equipment as part of their total capability. Two California industry cooperatives have designed dispersant spray systems that are attached to existing advancing recovery devices, thus providing the largest spray systems yet developed for any surface vessels. Detailed calibration of the systems has been done and has provided tables and charts which can be used by both management and operators for direction of dispersant application programs. Close control of dispersant dosage is a requirement for successful dispersant application and also for accurate documentation for regulatory authorities. The calibration work reported here has also shown the variability that can be found in very similar systems and indicated the need for careful evaluation of educator performance, as well as the value of use of accurate metering pumps for dispersant, whether used diluted or undiluted. (See also W90-02334) (Author's abstract)
W90-02354

TROPICAL OIL POLLUTION INVESTIGATIONS IN COASTAL SYSTEMS (TROPICS): THE EFFECTS OF UNTREATED AND CHEMICALLY DISPERSED PRUDHOE BAY CRUDE OIL ON MANGROVES, SEAGRASSES, AND CORALS IN PANAMA.
RPI International, Inc., Columbia, SC.
For primary bibliographic entry see Field 5C.
W90-02355

DISPERSED OIL EFFECTS ON TROPICAL NEARSHORE ECOSYSTEMS.
Greater Caribbean Energy and Environment Foundation, Miami, FL.
For primary bibliographic entry see Field 5C.
W90-02356

USING THE HAZARD MITIGATION PROCESS TO IDENTIFY INTERACTIVE HAZARD LOCATIONS IN BASE FLOODPLAINS.
Washington State Dept. of Ecology, Olympia.
For primary bibliographic entry see Field 6A.
W90-02384

URBAN RUNOFF--SWEDISH EXPERIENCE.
National Swedish Environment Protection Board, Solna.
For primary bibliographic entry see Field 5E.
W90-02413

CONCENTRATION LIMITS FROM A TECHNICAL STANDPOINT.
K-konsult, Stockholm (Sweden).
For primary bibliographic entry see Field 5D.
W90-02417

LIMIT VALUES IN SPECIAL AGREEMENTS BETWEEN FACTORIES AND SEWAGE WORKS.
Helsinki Metropolitan Area Water Co. (Finland).
For primary bibliographic entry see Field 5D.
W90-02418

CONDITIONS FOR INDUSTRIAL EFFLUENT DISCHARGES TO THE MUNICIPAL SEWERAGE SYSTEM.
State Commission for Hydrometeorology Environment Control, Institute of Applied Geophysics, Baltic Branch, Jarvevana tee 5 SU-200001. Tallinn, Estonia, USSR.
For primary bibliographic entry see Field 5D.
W90-02419

KARST HYDROGEOLOGY AND KARST ENVIRONMENT PROTECTION.
For primary bibliographic entry see Field 2F.
W90-02444

GROUNDWATER QUALITY MONITORING AS A TOOL OF GROUNDWATER RESOURCES PROTECTION.
Ustredni Ustav Geologicky, Prague (Czechoslovakia).
For primary bibliographic entry see Field 5A.
W90-02453

KARST ENVIRONMENT PROTECTION IN NORWAY.
Bergen Univ. (Norway). Dept. of Geology.
S.E. Lauritzen.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 109-114. 2 fig, 9 ref.

Descriptors: *Water pollution prevention, *Karst, *Environmental protection, *Norway, *Water resources development, Caves, Management planning.

The formation of karst is due to delicate equilibrium processes of hydrochemical and biological nature which are easily disturbed by man. The lack of filtration effects in karst conduit and fissure aquifers make them extremely vulnerable to pollution. Hence, karst landforms need protection and management, which is dependent on evaluation and a consistent strategy. Norway has a relatively modest amount of karst, but of an exotic quality. Therefore, a national program for karst registration and evaluation was developed. Three categories of value were used: scientific value, aesthetic recreation value and physical recreation value. The combination of these criteria gave rise to three categories of objects: research and reference ob-

jects, teaching and tourist objects and sporting objects. Gating is the ultimate protection strategy of cave localities, and may be the only one which effectively prevents vandalism over time. (See also W90-02444) (Author's abstract)
W90-02455

KARST ENVIRONMENT OF GUIYANG CITY--ITS MANAGEMENT AND PROTECTION.
The NO. 1 Hydrogeology and Engineering Geology Party of Guizhou, Guiyang, China.
For primary bibliographic entry see Field 4B.
W90-02460

PROTECTION OF HIGHLY PERMEABLE AQUIFERS AGAINST CONTAMINATION BY XENOBIOTICS.
Bundesgesundheitsamt, Berlin (Germany, F.R.). Inst. fuer Wasser-, Boden- und Lufthygiene.
K. Milde, G. Milde, B. Ahlsdorf, N. Litz, and U. Muller-Wegener.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 194-201. 8 fig, 11 ref.

Descriptors: *Water pollution prevention, *Pesticides, *Groundwater pollution, *Nonpoint pollution sources, *Herbicides, *Karst hydrology, Environmental effects, Aquifer management.

In modern societies, xenobiotics are of such widespread use that the quality of groundwater in vulnerable aquifers is highly endangered. To show how protective measures against nonpoint sources may protect groundwater supplies, the agricultural use of an important herbicide (atrazine) in vulnerable Malm karst and Pleistocene outwash sand regions was investigated. The results of the study permit the following protective measures to be recommended: (1) In the drainage area of highly vulnerable karst aquifers, atrazine and substances similarly endangering groundwater must not be used. (2) In areas of highly vulnerable sand aquifers the area treated with atrazine should not exceed 15% of the recharge region. (See also W90-02444) (Author's abstract)
W90-02465

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

ENVIRONMENTAL IMPACT ASSESSMENT OF YANGTZE VALLEY PROJECTS.
Yangtze Water Resources Protection Bureau, Wuhan (China).
For primary bibliographic entry see Field 6G.
W90-02041

ASSESSMENT OF RESEARCH ON NATURAL HAZARDS.
Colorado Univ., Boulder. Inst. of Behavioral Science.
For primary bibliographic entry see Field 6F.
W90-02295

SEWAGE TREATMENT STRATEGY FOR THE COLWYN AND ABERCONWY AREAS--AN APPRAISAL OF OPTIONS.
Welsh Water Authority, Powys.
For primary bibliographic entry see Field 5D.
W90-02327

THANET SEWAGE DISPOSAL INVESTIGATION AND THE COMPARISON OF JOINT AND LOCAL SOLUTIONS.
Southern Water Authority, Worthing (England).
For primary bibliographic entry see Field 5D.
W90-02328

ECONOMIC ASSESSMENT OF INLAND TREATMENT AND MARINE TREATMENT OPTIONS FOR WEYMOUTH AND PORTLAND.
Wessex Water Authority, Bristol (England).
For primary bibliographic entry see Field 5D.
W90-02329

SEWAGE SLUDGE TO SEA--THE THAMES WATER APPROACH.
Thames Water Authority, London (England).
For primary bibliographic entry see Field 5E.
W90-02330

USE OF A COMPUTERIZED SPILL RESPONSE TOOL FOR EMERGENCY RESPONSE, PERSONNEL TRAINING, AND CONTINGENCY PLANNING.
For primary bibliographic entry see Field 5G.
W90-02342

COMPUTER-ASSISTED PLANNING SYSTEM FOR OIL SPILL RESPONSE CHEMICAL APPLICATIONS.
Alaska Clean Seas, Anchorage.
For primary bibliographic entry see Field 5G.
W90-02344

APPROACHES TO PLANNING FOR DISPERSANT USE IN OIL SPILL RESPONSE.
Environmental Sciences, Los Angeles, CA.
For primary bibliographic entry see Field 5G.
W90-02345

PLANNING FOR DISPERSANT USE.
Shell Oil Co., Houston, TX.
For primary bibliographic entry see Field 5G.
W90-02346

NOT ALL FLOODS ARE CREATED EQUAL: TOWARD A COMPREHENSIVE ASSESSMENT OF FLASH FLOODS IN THE UNITED STATES.
Colorado Univ., Colorado Springs.
For primary bibliographic entry see Field 2E.
W90-02383

USING THE HAZARD MITIGATION PROCESS TO IDENTIFY INTERACTIVE HAZARD LOCATIONS IN BASE FLOODPLAINS.
Washington State Dept. of Ecology, Olympia.
T. D'Acci.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 144-148.

Descriptors: *Flood plain management, *Hazardous materials, *Government supports, *Cleanup operations, *Water pollution control, *Water pollution prevention, Water pollution sources, Governmental interrelations, Flood protection, Flood damage, Contamination, Communication, Disasters, Fuel, Washington.

Major flooding within the Chehalis River Basin, Washington, occurs during the winter monsoon from November through March. Flooding is the result of heavy rainfall augmented by snowmelt. Many industries related to wood products have located in the county seat, Chehalis, such as the American Crossarm Company, which manufactures a preservative mixture of diesel oil and pentachlorophenol, commonly called Penta. In 1986, after days of intense rain and warming temperatures across western Washington, floodwaters swept into the American Crossarm facility and displaced much of the stored Penta. Four square blocks of the city of Chehalis were inundated by the contaminated water. The Department of Ecology and the local government responded initially; as the complexity of the spill was realized, EPA staff and the Coast Guard were brought in. The cleanup was thorough and effective. In the aftermath of the flooding, some immediate conclusions were apparent. Internal communication in the Department of Ecology must be improved. It is imperative to recognize and evaluate the links between interactive hazards before the disaster occurs. Recommendations produced by the cleanup team were: (1) that the FEMA-EPA Oil and Hazardous Material Spill Contingency Plan be revised, and (2) implementation of a pilot project designed to identify hazardous materials locations subject to base flooding. Using technical assistance, site-by-site triage process would identify the sites most subject to an interactive threat. Site-specific flood fighting plans would be developed in conjunction with the concerned businesses. (See also W90-02368) (Fish-PTT)
W90-02384

FLOOD DEPTH AS A CRITERION FOR CONTROLLING FLOODPLAIN DEVELOPMENT.
Dewberry and Davis, Fairfax, VA.
For primary bibliographic entry see Field 6F.
W90-02390

FLOODPLAIN MANAGEMENT THROUGH THE COMMUNITY PLANNING PROCESS IN SAN DIEGO COUNTY.
San Diego County Dept. of Planning and Land Use, CA.
For primary bibliographic entry see Field 6F.
W90-02394

APPLICATION OF FREQUENCY AND RISK IN WATER RESOURCES: PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON FLOOD FREQUENCY AND RISK ANALYSES, 14-17 MAY 1986, LOUISIANA STATE UNIVERSITY, BATON ROUGE, U.S.A.
For primary bibliographic entry see Field 2E.
W90-02507

APPLICATION OF PROBABLE MAXIMUM FLOOD ESTIMATES TO THE DESIGN OF WATER RESOURCE DEVELOPMENT PROJECTS.
Harza Engineering Co., Chicago, IL.
For primary bibliographic entry see Field 2E.
W90-02509

DEVELOPMENT OF DESIGN PROCEDURES FOR EXTREME FLOODS IN AUSTRALIA.
New South Wales Univ., Kensington (Australia). School of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02512

DESIGN FLOODS FOR CANAFISTO DAM.
Integral S.A., Medellin (Colombia).
For primary bibliographic entry see Field 2E.
W90-02513

EXPERIENCES OF DESIGN FLOOD OF RESERVOIRS IN MEDIUM AND SMALL BASINS BY THE METHOD OF DESIGN STORM.
Nanjing Hydrological Research Inst. (China).
For primary bibliographic entry see Field 2E.
W90-02514

ESTIMATION OF DESIGN FLOOD.
I and P (WB) Dn. II, IDUP, Roorkee, UP, India.
For primary bibliographic entry see Field 2E.
W90-02515

DESIGN FLOOD ESTIMATION FOR NARMADA SAGAR PROJECT USING PARTIAL DURATION SERIES - A CASE STUDY.
National Inst. of Hydrology, Roorkee (India).
For primary bibliographic entry see Field 2E.
W90-02516

DESIGN FLOOD COMPUTATION WITH LIMITED DATA - CASE STUDY OF A RESERVOIR IN SUBERNREKHA RIVER BASIN.
Bihar Coll. of Engineering, Patna (India). Dept. of Civil Engineeering.
For primary bibliographic entry see Field 2E.
W90-02517

Group 6A—Techniques Of Planning

REVIEW OF ADVANCES IN RISK AND RELIABILITY ANALYSIS FOR HYDRAULIC STRUCTURES.
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02526

PROJECT RISK CONSIDERING SAMPLING UNCERTAINTIES AND A FINITE PROJECT OPERATION PERIOD.
Utah Univ., Salt Lake City. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02530

OPTIMAL PLANNING OF FLOOD CONTROL SYSTEMS BASED ON RISK ANALYSES OF FLOOD INUNDATION.
Gifu Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02531

FLOOD HAZARD ASSESSMENT ON ALLUVIAL FANS: AN EXAMINATION OF THE METHODOLOGY.
Nevada Univ., Las Vegas. Center for Water Resources Research.
For primary bibliographic entry see Field 2E.
W90-02534

6B. Evaluation Process

RESOURCE POLICY IN THE EVERGLADES AGRICULTURAL AREA: A HISTORICAL AND ECONOMIC PERSPECTIVE.
Florida Univ., Gainesville. Dept. of Forestry.
For primary bibliographic entry see Field 6E.
W90-01966

ECONOMIC EVALUATION OF DISPERSANTS TO COMBAT OIL SPILLS.
Texaco, Inc., Beacon, NY.
For primary bibliographic entry see Field 5G.
W90-02338

FIELD MEASUREMENT OF EFFECTIVENESS: HISTORICAL REVIEW AND EXAMINATION OF ANALYTICAL METHODS.
Environment Canada, Ottawa (Ontario). Environmental Emergencies Technology Div.
For primary bibliographic entry see Field 5G.
W90-02350

KISSIMMEE RIVER: FLOODPLAIN HARMONY IN RESTORATION.
South Florida Water Management District, West Palm Beach.
For primary bibliographic entry see Field 4A.
W90-02376

QUANTITATIVE ASSESSMENT OF THE IMPACT OF FLOODPLAIN MANAGEMENT STRATEGIES ON RESIDENTIAL DAMAGE.
New South Wales Dept. of Public Works, Sydney (Australia).
J. R. Bodycott, and C. S. Joy.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 149-154, 3 fig, 3 ref.

Descriptors: *Flood plain management, *Flood damage, *Flood plain zoning, *Land development, *Community development, Tidal floods, Government supports, Policy making, Flood control, Australia.

The government of New South Wales (NSW), Australia, continually assesses its policies and programs to ensure that they are effective and that the public receives value for money spent. A study was undertaken to quantify the effectiveness of flood plain development strategies in the coastal flood plains of NSW, where flood plain management is supervised by the Public Works Department (PWD). This investigation had the following objectives: (1) to quantify current potential flood damage on tidal flood plains, (2) to quantify the rate of increase of potential damage over time, (3) to identify factors that have influenced the growth in potential damage, and (4) to quantify the effectiveness of government policies and strategies in limiting the rate of growth of damage. As part of this study, 11 representative flood-prone communities on the coastal flood plains of NSW were investigated in detail. Results are presented for potential residential damage in two towns: Murwillumbah and Bankstown. Community actions have significantly reduced flood damage potential. A variety of factors influence the rate of growth in average annual potential flood damage to dwellings in the coastal flood plains of NSW, and affect the rate of growth in different ways in different towns. The quantification of these effects requires considerable effort, but provides an objective basis for assessing the effectiveness of flood plain control measures. (See also W90-02368) (Fish-PTT)
W90-02385

ANATOMY OF LOSSES TO STATE AND LOCAL GOVERNMENT PROPERTY FROM NATURAL DISASTERS.
North Carolina Univ., Chapel Hill. Center for Urban and Regional Studies.
R. J. Burby, and J. D. Kartez.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 155-164, 1 tab.

Descriptors: *Flood damage, *Public policy, *Economic impact, *Government supports, *Alternative planning, Federal jurisdiction, Surveys, Hazards, Disasters, Economic aspects, Floods, Hurricanes, Earthquakes.

In 1980 the net stock of fixed assets (structures and equipment) owned by state and local governments in the United States totalled over $2,034.8 billion. Every year, however, state and local governments lose hundreds of millions of dollars in public property damaged as a result of floods, hurricanes, earthquakes, and other natural disasters. Newly assembled data is used from federal records and survey research to look more closely at the nature of those losses and their implications for public policy. Information is reported from three sources of data: Federal Emergency Management Agency records of losses; U.S. Department of Transportation records of losses; and data on loss recovery, hazard mitigation, and public officials' attitudes toward policy alternatives obtained from mail surveys. The data suggest two courses of action. The first is to explore alternative policies for coping with losses to infrastructure damaged in natural disasters. The second course of action is to assess the potential for decreasing existing and future losses to infrastructure through increased adoption of hazard mitigation measures. (See also W90-02368) (Fish-PTT)
W90-02386

POST-FLOOD DAMAGE ASSESSMENT AND REDUCING THE COST OF DISASTER.
Federal Emergency Management Agency, Washington, DC.
M. G. Mahoney.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 165-170.

Descriptors: *Governmental interrelations, *Flood damage, *Floodproofing, *Urban planning, Structural engineering, Economic aspects, Flood control, Government supports, Maintenance, Construction, Utilities, Structural engineering, Levees, Floodwater, Flood protection.

There are several relatively low-cost steps that could be encouraged or required by officials at the local level at the time that a flood-damaged structure is being repaired that would help to mitigate future flood damage. A series of flood scenarios is presented, describing what type of damage occurs and why, and providing a series of low-cost options that could be pursued at the local government level to reduce future structural flood losses. To combat indirect basement flooding, one can retrofit the basement to prevent water from entering through openings and weak points. For new construction, the solution to direct basement flooding may be to construct a floodproofed basement. The best solution to prevent flood damage to basement utilities and external utilities is to elevate the utilities above potential flood levels. There are a large number of potential methods that could be used to reduce future flood damages to a structure subject to low-level flooding, such as to wet floodproof the building, to install mini-structures (levees and flood walls) designed to keep floodwater away from the building, or using the structure's walls to provide flood protection. There are a number of techniques that could be utilized during the repair of a damaged structure that will go a long way to reducing that structure's susceptibility to future flood damages. These are methods that could be planned for and encouraged or even required at the local or state level. The benefit of such a program is that it could be tailored to local conditions, making it more practical for the property owner and more effective for the community. (See also W90-02368) (Fish-PTT)
W90-02387

MULTI-OBJECTIVE DECISION CRITERIA FOR ASSISTING LOCAL OFFICIALS IN MITIGATION PLANNING.
Mitigation Assistance Corp., Boulder, CO.
For primary bibliographic entry see Field 6F.
W90-02392

REGIONAL FLOOD CONTROL PROJECTS IN HARRIS COUNTY, TEXAS.
Harris County Flood Control District, Houston, TX.
For primary bibliographic entry see Field 4A.
W90-02395

EVALUATION OF FINANCIAL RISK.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2E.
W90-02528

FLOOD RISK BIAS ANALYSED THROUGH A MULTI-STATE FLOOD INSURANCE MODEL.
Victoria Dept. of Water Resources, Armadale (Australia).
For primary bibliographic entry see Field 7C.
W90-02536

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

FINANCING ALTERNATIVES FOR AGRICULTURAL NONPOINT SOURCE POLLUTION CONTROL PROGRAMS.
Illinois Univ. at Urbana-Champaign. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 5G.
W90-02302

FROM HARM'S WAY: FLOOD-HAZARD MITIGATION IN TULSA, OKLAHOMA.
Tulsa, OK.
For primary bibliographic entry see Field 6F.
W90-02396

6D. Water Demand

TUBEWELL WATER CONSUMPTION AND ITS DETERMINANTS IN A RURAL AREA OF BANGLADESH.
International Centre for Diarrheal Disease Research, Dacca (Bangladesh).
B. A. Hoque, S. R. A. Huttly, K. M. A. Aziz, M. Y. Patwary, and R. G. Feachem.

Journal of Tropical Medicine and Hygiene JTMHA9, Vol. 92, No. 3, p 197-202, 1989. 1 fig, 1 tab, 8 ref.

Descriptors: *Water use, *Well water, *Bangladesh, Rural areas, Sanitation, Hygiene.

As part of the evaluation of a water supply, sanitation, and hygiene education project in rural Bangladesh, the consumption of water from the improved supplies was estimated from an observational study. Women volunteers observed and recorded all water collection activities of each group of households using a handpump over a 2-day period. Data from questionnaire surveys on household characteristics were related to per capita use of water. The mean household water consumption rate was 43 L per capita per day. Univariate analyses showed that several factors were significantly associated with water consumption, including family size and age structure, occupation, distance from the house to the handpump, the number of people served by a handpump, and possession of luxury items. Multiple regression analysis showed that several factors remained associated with per capita consumption, although their predictive value was low. This method of data collection enabled the quantitative study of a variable which water-supply projects strive to increase--the volume of water used per capita per day. The project was clearly successful in achieving high rates of water consumption. However, despite a high handpump to population ratio, consumption, did vary widely between households according to several factors. Consideration of these factors is of importance in the planning and siting of handpumps in similar water-supply projects, and in defining those households which are to be the main targets of associated health and hygiene education. (Shidler-PTT)
W90-01955

ROLE OF HYDROPOWER IN THE WORLD'S ENERGY SUPPLY.
K. Goldsmith.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 9 p 22-24, September 1989.

Descriptors: *Hydroelectric power, *Energy sources, *Water resources development, *Future planning, Economic aspects, Environmental effects, Electrical transmission, Developing countries.

Hydropower is a non-polluting renewable energy source with an inherently long asset life. Its development requires three primary constraints to be addressed: (1) power markets of the right size and structure must be found within feasible transmission distances; (2) ecological and environmental problems must be overcome; and (3) funding for the very considerable initial investment requirements must be secured. Economy demands the exploitation of a hydropower source on the maximum feasible scale, and this can mean that projects awaiting development may be ahead of their economic time because, for the foreseeable future, their output cannot be absorbed by the available loads. The increasing range, load-transfer capability, and efficiency of power transmission has enabled geographically-tied hydro plants to take advantage of power markets much farther afield. Imported hydro energy must, of course be competitive in price; the benefits of bringing it from farther away must outweigh any extra costs resulting from a different pattern of power flow in the network. Environmental concerns can be greatly mitigated by giving adequate information to the parties directly affected, and also to the public at large, and by offering realistic compensation for any disturbance caused. Finding adequate funds for hydropower development does not present a major obstacle in the industrialized world. The situation of the developing countries is materially different; hydro schemes intended to form an integral component in a power-systems expansion scheme are not necessarily easy to fund, but their economic impact is usually more directly measurable, the uncertainty of adequate expenditure recovery is lower and the credit rating accorded to them by governments and financing agencies is correspondingly higher. (Ence-PTT)
W90-02127

THREATS TO THE WORLD'S WATER.
International Council of Scientific Unions, Paris (France).
J. W. Maurits la Riviere.
Scientific American SCAMAC, Vol. 261, No. 3, p 80-94, 1989. 4 ref.

Descriptors: *Water scarcity, *Water use, *Water supply, *Water quality, *Water pollution sources, Water pollution effects, International agreements, Policy making, Irrigation effects, Groundwater mining, Water quality management.

Water may well be the most precious resource the earth provides to humankind. Yet people have been remarkably shortsighted in maintaining natural reservoirs and safeguarding water purity. There is, in principle, enough water to sustain 20 billion people. However, both the world's population and usable water are unevenly distributed making water-poor and water-rich countries. Local water shortages can be solved by increasing the supply by damming rivers, by 'mining' groundwater, or by conserving water with more efficient irrigation. Population, agricultural, and industrial growth contribute to the scarcity of water. Overirrigation increases the salinity of available water. Deforestation and excessive logging increase the amount of water that reaches the floodplain. The climatic change resulting from greenhouse warming could increase the ratio of salt water to fresh water on the globe. The quality of our water resources is threatened by many kinds of pollution, both organic waste and waste generated by industrial processes. Pollutants in the air enter the water cycle. Soluble nitrates pollute groundwater in areas of intensive animal farming. The oceans and coastal wetlands are increasingly endangered. Management of water resources, of both their quality and quantity, must integrate the efforts of governmental and intergovernmenta agencies. Projects should lean toward increasing the efficiency of water consumption rather than toward increasing the supply of water. Mining of groundwater should be avoided at all costs. Prevention of pollution and the restoration of bodies of water that are already polluted should gradually take precedence over the development of purification technologies. Also needed is more research on the hydrosphere.(Ence-PTT)
W90-02132

STRATEGIES FOR AGRICULTURE.
Resources for the Future, Inc., Washington, DC. Energy and Natural Resources Div.
P. R. Crosson, and N. J. Rosenberg.
Scientific American SCAMAC, Vol. 261, No. 3, p 128-135, 1989. 5 ref.

Descriptors: *Water allocation, *Crop production, *Agriculture, *Irrigation, *Land management, Farm management, Range management, Soil erosion, Urbanization, Attitudes.

As the human population approaches a stable level, the food supply must expand in a way that does not destroy the natural environment. A steady stream of new technologies that minimize erosion, desertification, salinization of the soil and other environmental damage must be introduced. The three critical resources are land, water, and genetic diversity. Agricultural land is threatened by wind and water erosion, degradation of rangelands in arid, semiarid, and subhuimid regions, waterlogging and salinization of irrigated lands, and the conversion of rural land to urban uses. There has been a steady increase in competition for water--a competition in which agriculture does not fare well. In parts of the world water supplies are threatened by the buildup of silt in reservoirs. An example of sharp reductions in genetic diversity resulting from monocropping occurred in the U.S. in 1970 when corn production was reduced 15 percent by a fungus well matched to the 'T-cytoplasm' that had been incorporated in most of the hybrid seed corn. New technologies in three categories are particularly important: those that reduce the environmental burden of pesticides and fertilizers, those that reduce the demand for irrigation water, and those that continue to improve crop production per hectare. If the agricultural-research establishment gets the support it needs, new technologies will be forthcoming. A more difficult task is to create the policies and institutions that will induce farmers to adopt the new technologies and management practices. Finding the mechanisms to accomplish this is the most important policy challenge for the world's agricultural development.(Ence-PTT)
W90-02133

INFLUENCE OF HYDROLOGICAL UNRELIABILITY ON WATER SUPPLY FROM RESERVOIRS (DER EINFLUSS DER HYDROLOGISCHEN UNSICHERHEIT AUF DIE VERSORGUNG DURCH WASSERKRAFTSPEICHER).
Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Wasserwessen.
G. Keser.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-82048/GAR. Price codes: E17 in paper copy, A01 in microfiche. 1986. 259p, 28 fig, 12 tab, 55 ref. English summary.

Descriptors: *Water supply, *Water demand, *Hydroelectric power, *Electric power production, *Reservoir operation, *Water resource management, Model studies, Flow rates, Tailwater, Dam effects.

The expected additional future electric power demands can be met by water reservoirs. However, reservoir planning does not generally include reliable data on prospective flow conditions. Tailwater flow simulation models forecasting future flow conditions can provide the basis for the planning of reservoirs in accordance with reasonable water resources policies. The forecast flows provide the input values in a functional model simulating the operational processes in water reservoirs. These analyses are limited to large-scale hydroelectric and pumped storage reservoirs. They can also be used to represent hydrologic information and to a forecast water demand. (Author's abstract)
W90-02272

INNOVATION AND ENVIRONMENTAL PROTECTION IN PLANTS OF THE TEXTILE FINISHING INDUSTRY: RESULTS OF A POSTAL INQUIRY (INNOVATION UND UMWELTSCHUTZ IN BETRIEBEND DER TEXTILVEREDLUNGSINDUSTRIE: ERGEBNISSE EINER POSTALISCHEN BEFRAGUNG).
C. Maas.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-81635/GAR. Price codes: E09 in paper copy, A01 in microfiche. 1987. 51p, 35 tab, 10 ref. English summary.

Descriptors: *Water use, *Industrial plants, *Textile mill wastes, *West Germany, *Environmental effects, Resources management, Economic aspects, Regulations, Surveys.

A postal survey of West-German textile finishing plants show that innovations in the textile finishing industry are mostly directed toward automation and reduction in water, energy, and chemical use. Innovations primarily directed towards economic aspects have contributed to a reduction of water discharge because these emissions result from an inefficient use of resources. Water costs are low in establishments with wells of their own; therefore, they have a much lower incentive for reduction of water use compared to plants that have to buy water from water suppliers. Regulations have forced half of the plants responding to limit their waste water discharge. Twenty percent were in violation of air pollution regulations; 10% had to reduce their noise level at night. Regulations have not had a strong influence on the development and/or adoption of more efficient environmental solutions, but business innovations have decreased emissions in the textile finishing industry as a side effect. (Author's abstract)
W90-02284

ASSESSMENT AND DEVELOPMENT--MANAGEMENT PATTERNS OF KARST WATER RESOURCES IN CHINA.
Ministry of Geology and Mineral Resources, Beijing (China). Bureau of Hydrogeology and Engineering Geology.
Z. Wang.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 47-57. 2 fig, 1 tab, 4 ref.

Descriptors: *China, *Karst hydrology, *Water resources development, *Karst, Geological surveys, Water pollution control, Water demand.

China is abundant in karst water resources. The karst water system in northern China is characterized by continual regulation of the water resources and a large, stable quantity during the spring outflow. The development-management pattern is of four types: (1) water diversion; (2) water extraction; (3) a combination of surface and underground reservoirs; and (4) a mixed type, which includes water collection, diversion, extraction, and power generation. The objective of this strategy is to: obtain benefits from the joint utilization of surface and groundwater; control flood waters and balance water demands; and to prevent water pollution. In order to improve management plans, model studies were conducted. Darcy's flow model was applicable to the karst region in northern and central China where corroded fissures and caverns dominate. The lumped parameter model could also be used for these regions. Using these techniques, control objectives and major environmental and geological considerations have been determined in conjunction with development-management patterns for karst-spring domain, shallow-buried karst, coastal karst, and underground river systems. (See also W90-02444) (Mertz-PTT)
W90-02449

CONFLICT BETWEEN GROUNDWATER EXPLOITATION AND LIMESTONE QUARRYING IN THE KARST REGION OF WARSTEIN (FEDERAL REPUBLIC OF GERMANY).
Geologisches Landesamt Nordrhein-Westfalen, Krefeld (Germany, F.R.).
For primary bibliographic entry see Field 4C.
W90-02463

6E. Water Law and Institutions

GWALTNEY OF SMITHFIELD V. CHESAPEAKE BAY FOUNDATION: BALANCING INTERESTS UNDER THE CLEAN WATER ACT.
L. L. Shea.
San Diego Law Review SDLRDO, Vol. 25, No. 4, p 857-878, 1988. 94 ref.

Descriptors: *Judicial decisions, *Water law, *Legal aspects, Regulations, Clean Water Act, Chesapeake Bay Foundation, Water pollution, Chlorine, Coliforms, Nitrogen.

Gwaltney, a subsidiary of Smithfield Foods, Inc., owned and operated a meat-packing plant near Smithfield, Virginia. Due to violations of Gwaltney's National Pollution Discharge Elimination System (NPDES) permit, Chesapeake Bay Foundation, Inc., and National Resources Defense Council filed a citizen suit pursuant to section 1365 of the Clean Water Act. The Citizen's right to enforce provisions of the Clean Water Act by bringing suit against violators in federal court is examined in this article. In Gwaltney of Smithfield v. Chesapeake Bay Foundation, the Supreme Court was faced with balancing the citizen-plaintiff's interest in enforcing pollution-control laws against the industrial-defendant's interest in adequately defending pollution enforcement suits and remaining free from frivolous actions. The issues in this case were the citizen's right to bring suit for damages created through past violations of the Clean Water Act and the requirements which the citizen-plaintiff must meet to receive standing. The findings of the District Court indicate that Gwaltney violated its permit limitations on total Kjeldahl nitrogen, chlorine and fecal coliform on many occasions between October 27, 1981 and August 30, 1984. Due to installation of new chlorination equipment in March 1982, the last reported chlorine violation occurred in October 1982, and the last reported coliform violation occurred in February 1984. Due to an upgraded wastewater treatment system in October 1983, the last total Kjeldahl nitrogen violation occurred on May 15, 1984. In resolving Gwaltney, the Supreme Court was confronted with a three-way split among the circuits regarding whether plaintiffs could bring an enforcement action agaist a polluter's wholly past violations of the Clean Water Act. In resolving this division among the circuit courts, the Supreme Court held that section 1365 did not permit citizen suits for wholly past violations. This restrictive holding was modified by the introduction of an allegation-based system of federal court jurisdiction under the Clean Water Act: a good-faith allegation of continuous or intermittent violation was held to invoke the subject matter jurisdiction of the federal courts. (Mertz-PTT)
W90-01945

RESOURCE POLICY IN THE EVERGLADES AGRICULTURAL AREA: A HISTORICAL AND ECONOMIC PERSPECTIVE.
Florida Univ., Gainesville. Dept. of Forestry.
R. C. Abt, and W. L. Finger.
Journal of Environmental Management JEVMAW, Vol 29, No. 1, p 83-93, July 1989. 4 fig, 2 tab, 13 ref.

Descriptors: *Florida, *Everglades, *Land development, *Land management, *Land use, *Environmental protection, Interagency cooperation, Agriculture, Economic aspects.

The state of Florida is currently considering options for reducing the environmental consequences of drainage and development encouraged by historical land-use policies. One aspect considered is the regional, economic and temporal interrelationships between policies of different agencies. The interaction of state resource policy and national agricultural policy are shown to affect both the level and distribution of environmental costs. Therefore, a multi-disciplinary team was established to address the question of how to mitigate the environmental consequences of current land use in the Everglades and assess the economic aspects of the agricultural policies. The analyses include: (1) an analysis of the engineering projects in terms of fixed and variable costs; (2) the multiplier impact of the industry on the local economy; and (3) the cost of returning the lands to their natural state. The effectiveness of the environmental policy options available to the state has been shown to depend on national agricultural policy. The equity of current policy in terms of responsibility for environmental costs is determined by past policy. The current policy of paying for environmental projects to offset the effects of drainage on all land currently in production is probably among the least efficient from an economic point of view. (White-Reimer-PTT)
W90-01966

GOVERNMENT'S PROPOSALS FOR THE RESTRUCTURING AND PRIVATIZATION OF THE WATER AUTHORITIES IN ENGLAND AND WALES.
Department of the Environment, London (England).
P. N. Bristow.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1527-1530, 1989. 10 ref.

Descriptors: *Water management, *Governmental interrelations, *England, *Environmental policy, *Wales, Privatization, Public health, Economic aspects, Management planning, Political aspects, Water quality control.

A February 1986 White Paper on the 'Privatization of the Water Authorities in England and Wales' proposed private sector operation of the water authorities to bring the following benefits: (1) the authorities would be free of Government intervention in day to day management and protected from fluctuating political pressure; (2) they would have access to the private sector capital markets, making it easier to pursue effective investment strategies for cutting costs and improving standards of service; (3) the financial markets would be able to compare the performance of individual water authorities against each other and against other sectors of the economy, providing a financial spur to improved performance; (4) the privatised authorities would be able to attract high quality managers from other parts of the private sector; (5) employees would be more closely involved with their business especially through their ownership of shares, and motivated to ensure its success. The proposals also made it clear that the Government would continue to be responsible for public health standards, above all for the quality of drinking water, and for the framework of environmental standards within which the privatized companies would exercise the powers to control abstractions from and discharges to rivers and other waters which they would take over from the water authorities. The latter aspect of the proposals attracted particularly strong criticism from a number of groups whose members had a direct interest in the way in which water resources were managed. As a result of these criticisms, in May 1987 the government announced the establishment of a National Rivers Authority (NRA) to takeover the water authorities' responsibilities for water resources regulation and planning, environmental quality and pollution control, land drainage and flood protection, fisheries, conservation and recreation. The NRA would have full responsibility not only for the regulatory functions of water authorities but also the broader range of river management functions. (Sand-PTT)
W90-02090

EUROPEAN COMMUNITY ACTIVITIES TOWARDS THE PROTECTION OF THE MARINE ENVIRONMENT.
Commission of the European Communities, Brussels (Belgium). Protection and Management of Water.
For primary bibliographic entry see Field 5G.
W90-02318

DISPERSANT USE GUIDELINES FOR FRESHWATER AND OTHER INLAND ENVIRONMENTS.
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W90-02336

DISPERSANT USE CONSIDERATIONS.
Coast Guard, Washington, DC. Pollution Response Branch.
For primary bibliographic entry see Field 5G.
W90-02347

OIL DISPERSANT GUIDELINES: ALASKA.
National Ocean Service, Rockville, MD.
For primary bibliographic entry see Field 5G.
W90-02348

LETTERS OF AGREEMENT FOR THE USE OF DISPERSANTS.
Coast Guard District (7th), Miami, FL. Marine Environmental Protection Branch.
For primary bibliographic entry see Field 5G.
W90-02349

SUBSTANTIAL IMPROVEMENT: EXISTING PROBLEMS AND POTENTIAL SOLUTIONS.
Federal Emergency Management Agency, Washington, DC.
For primary bibliographic entry see Field 6F.
W90-02388

FLOOD-RESISTANT CONSTRUCTION STANDARDS IN THE NATIONAL MODEL BUILDING CODES.
Federal Emergency Management Agency, Wash-

ington, DC.
For primary bibliographic entry see Field 6F.
W90-02389

LOCAL GOVERNMENTS LIKE NONSTRUCTURAL MEASURES TOO.
Corps of Engineers, Atlanta, GA.
For primary bibliographic entry see Field 6F.
W90-02393

EVALUATING FLOOD HAZARDS ON ALLUVIAL FANS.
Baker (Michael), Jr., Inc., Alexandria, VA.
For primary bibliographic entry see Field 2E.
W90-02399

LEGAL PROBLEMS IN KARST TERRANES.
P. E. LaMoreaux.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 103-108.

Descriptors: *Groundwater depletion, *Karst, *Karst hydrology, *Florida, *Phosphates, *Groundwater management, Legal aspects, Groundwater pollution, Phosphate mining, Land use.

Phosphate mining in Florida requires large quantities of water for processing. Beneath the Central Florida Phosphate District the Floridan Aquifer is capable of producing millions of gallons per day from individual wells in limestone. The present combined use of ground water by the phosphate industry exceeds 300 million gallons per day. The production of this water, plus that used for industrial, agricultural, and municipal uses has resulted in large overlapping cones of depression in the Floridan Aquifer. In addition to problems of water rights, there are associated environmental problems such as subsidence, diversion of streams, pollution, property damage, and litigation. In the United States, federal legislation may require companion legislation and rules in each state. (See also W90-02444) (Author's abstract)
W90-02454

KARST ENVIRONMENT PROTECTION IN NORWAY.
Bergen Univ. (Norway). Dept. of Geology.
For primary bibliographic entry see Field 5G.
W90-02455

6F. Nonstructural Alternatives

ASSESSMENT OF RESEARCH ON NATURAL HAZARDS.
Colorado Univ., Boulder. Inst. of Behavioral Science.
G. F. White, and J. E. Haas.
The MIT Press, Cambridge, Massachusetts. 1975. 487p, 54 fig, 25 tab, 169 ref.

Descriptors: *Disasters, *Hazards, *Research priorities, Geophysics, Frost, Lightning, Hail, Snow, Wind, Hurricanes, Tornadoes, Erosion, Landslides, Avalanches, Floods, Earthquakes, Volcanoes, Drought, Tsunamis.

This is a summary report on a research project that has been ongoing at the University of Colorado for the past several years. The project has generated a number of individual reports covering specific geophysical hazards, which have been distilled and brought together in this volume. The book covers the following kinds of natural hazards: frost, lightning, hail, urban snow, windstorm, hurricane, tornado, coastal erosion, landslide, avalance, earthquake, flood, tsunami, volcano eruption, and drought. The book not only examines actual disasters from the past, but also presents methods of simulating possible disasters. Therefore, one of its chapters simulates events that could occur in the future: a hurricane in Miami, an earthquake in San Francisco, a flood in Boulder, Colorado. (Lantz-PTT)
W90-02295

FLOODPLAIN HARMONY.
Proceedings of the Twelfth Annual Conference of the Association of State Floodplain Managers, May 16-19, 1988, Nashville, Tennessee. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. Special Publication No. 19. 378p.

Descriptors: *Flood plain management, *Conferences, *Symposium, Future planning, Floods, Flooding, Conservation, Hazards, Community development, Regional planning, State jurisdiction, Regulations, Arid-zone hydrology, Coastal zone management, Mapping, Computer programs, Resources development, Resources management, Tennessee.

The Association of State Floodplain Managers Twelfth Annual Conference was held in Nashville, Tennessee in May, 1988. The theme 'Floodplain Harmony, Note the Past--Tune the Future' provided an excellent mixture of formats and presenters tuned at shaping the future in flood plain and flood-risk management. The conference was divided into ten parts: Plenary Addresses, Floodplain Management and the Conservation of Natural and Beneficial Values, Increased Flood Hazard Awareness and Improved Flood Warning, Flood Assessment and the Evaluation of Floodplain Management Programs, Regulation and Floodplain Management, Community/Regional/State Floodplain Management, Flood Hazards and the Arid West, Flood Hazards and Coastal Areas, Mapping and Computational Tools for Floodplain Management, and The Status of the Nation's Floodplain Management Activity: Workshop Summaries. Each part contains from three to eight articles covering a comprehensive range of aspects of the respective topic. The conferees recognized that the field of flood plain and flood-risk management has come a long way in the past twenty years, but there still remains much to do and that the human resources exist to help each other to achieve these goals. (See W90-02368 thru W90-02411) (Fish-PTT)
W90-02368

CURRENT AND FUTURE DIRECTION OF THE CORPS OF ENGINEERS WATER RESOURCES PROGRAMS.
Corps of Engineers, Washington, DC.
H. J. Hatch.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 3-9.

Descriptors: *Flood plain management, *Water resources development, *Governmental interrelations, *Flood control, Interagency cooperation, Economic aspects, Engineering, Budgeting, Flood benefits, Benefits, Project planning, Legislation, Flood damage, Cost-benefit analysis.

Some changes have taken place in the U.S. Army Corps of Engineers water resource programs since 1986, when the Water Resources Development Act helped define the roles that federal, state, local, and private sectors have to play in meeting the nation's flood control and other water resource needs, not only in terms of authorizations, but, more importantly, in establishing the ground rules for a partnership in water resources. In formulating the budget and recommending new starts, the Corps of Engineers follows Administration priorities; flood control and commercial navigation projects with good benefit-to-cost (B/C) ratios are more likely to be funded. In response to the 1986 Act, the Corps also undertook several actions to improve Corps efficiency. They are lumped together under the umbrella, 'Initiative '88.' One of the major Initiative '88 components is the reduction of time of project approval and funding procedures. A second major element of Initiative '88 is the 'Project Manager Concept,' providing continuity as the project goes from planning to design, to construction, to operation and maintenance. A unique element of Initiative '88 aims at research on improving productivity in the construction industry. The 1986 Act is hoped to be the framework on which future bills are based. The 1988 omnibus legislation is moving through Congress. The Corps' Flood Plain Management Services (FPMS) Program is a model of effective federal investment. The B/C ratio for the FPMS Program exceeds anything else the Corps is doing and probably anything the entire federal government is doing to reduce flood damages. (See also W90-02368) (Fish-PTT)
W90-02369

SOIL CONSERVATION SERVICE AND FLOODPLAIN MANAGEMENT: A LOOK AHEAD.
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 4A.
W90-02370

ENHANCING AWARENESS OF FLOOD-PRONE AREAS: THE DILEMMA OF TECHNICAL INFORMATION AND KNOWLEDGE HOLDING.
University of West Florida, Pensacola. Dept. of Political Science.
D. L. Soden.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 17-28, 2 fig, 19 ref.

Descriptors: *Water resources development, *Environmental policy, *Flood plain management, *Information exchange, Public policy, Public participation, Interagency cooperation, Policy making, Political aspects, Social aspects.

A review of the literature attendant to natural resource and environmental policy-making strongly suggests that a consensus does not exist about how to use natural resources. Technical information and knowledge-holding have potential roles in resolving conflicts which arise over the use and development of the nation's flood plains. Conflict surrounding flood plain issues may be lessened to a significant extent as technical information and knowledge-holding among the general public increases. Satisfaction, based on public policy-relevant knowledge, bears on the outcome of public decisions and can be a factor in resolving conflict about flood plain policy issues. It is proposed that information-holding will reduce complications surrounding both preservation and development of these valued natural assets. Policy makers should be led to promote greater flows of information between government agencies, developers, environmental interests and the general public, hopefully contributing to the development of a consensus about flood plain resources while, at the same time, meeting the goals of democratic societies. Natural resource policy conflicts are not disappearing from the political and social agenda. To the contrary, they will be one of the major issues facing policy makers for the remainder of this century and are definitely part of 'mainstream' American politics. Policy positions and preferences are likely to remain distinctively divided over the issue as long as the public remains poorly informed. (See also W90-02368) (Fish-PTT)
W90-02371

FLOODPROOFING BEHAVIOR OF HOMEOWNER FLOOD VICTIMS: THE CHICAGO EXPERIENCE.
New Orleans Univ., LA.
S. B. Laska, and J. A. Darlington.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 29-38, 3 ref.

Descriptors: *Floodproofing, *Flood protection, *Suburban areas, Flood damage, Financing, Insurance, Housing, Economic aspects, Government supports, Structural engineering.

Floodproofing is defined as design elements included in the construction of new homes or changes made to existing structures to protect them from

future flood damage. One reason why the government has not developed programs to assist in retrofitting structures is that homeowner flood victims would not voluntarily spend time, money, and effort to alter their homes. Two studies examined the retrofitting behavior of suburban New Orleans and the suburban Chicago area. The method of data collection was to mail a questionnaire to a sample of victims one year after the flood, designed to obtain information on victim and flood characteristics, retrofitting action, timing of retrofitting, exposure to retrofitting, profile of a retrofitter, attitudes toward retrofitting, and financing retrofitting. Findings from this study challenge the earlier explanations of why retrofitting was not recognized and supported by government programs. First, there is no doubt that retrofitting exists--at least in these two divergent cases. Second, the measures undertaken have been considerable, relatively expensive, and usually more than one. Third, all three types of flood protection measures--structural, nonstructural, and floodproofing--can be pursued at the same time. Finally, government recognition of retrofitting is both desired and needed by homeowners. Financial constraints were by far the most serious obstacle to desired retrofitting. Those homeowners who reported having been exposed to retrofitting information were more successful than those who were not. (See also W90-02368) (Fish-PTT)
W90-02372

FLOODPLAINS AND NATURAL HAZARD MANAGEMENT: THE DECADE AHEAD.
Geological Survey, Menlo Park, CA.
W. M. Brown.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 48-59, 2 ref.

Descriptors: *Landslides, *Disasters, *Earthquakes, *Warning systems, *Flood plain management, Flood forecasting, Planning, Automation, Rainfall intensity, Rainfall distribution, Mapping, Alluvial fans, Flood plains.

Earthquakes have significant flood-producing potential, and generate massive and widespread landslide activity; landslide disasters caused by heavy rainfall and high groundwater and surface-water conditions mostly occur concurrently with flooding. Better understanding of the interrelations among these natural phenomena is necessary for both immediate and long-range planning to minimize potentially disastrous impacts on communities. The U.S. Geological Survey (USGS) has planned a landslide hazards warning program based upon a type of landslide called debris flow, the conditions for debris flow to happen, debris flow hazard evaluation, and real-time hazard warning. The warning system is similar to a flood warning system, and uses automated telemetry (ALERT) stations. The data received at the USGS offices are compared with experimentally derived curves for thresholds of debris flow occurrence for different parts of the region. These curves indicate that there is a threshold of rainfall intensity, and a duration of rainfall of that intensity, for which debris flow activity will begin. It can be determined approximately how far away debris flow threshold conditions are and whether and when advisories and warnings should be issued. The decade ahead promises both refinement of the landslide warning system, particularly to include warnings about deeper seated landslides that commonly lag their causative rainfall by weeks to months. The future also promises innovative mapping technology plus further discoveries about debris flow and other landslide processes that may finally allow standards for coping with and perhaps regulating debris flow runout areas and alluvial fans. (See also W90-02368) (Fish-PTT)
W90-02373

EFFECT OF ACEC DESIGNATIONS ON PROPOSED DEVELOPMENT IN THE 100-YEAR FLOOD PLAIN.
IEP, Inc., Sandwich, MA.
S. M. Humphries.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 67-72, 1 ref.

Descriptors: *Coastal zone management, *Environmental policy, *Flood plain management, *Resources development, *Community development, Resources management, Wetlands, Environmental quality, Economic development, Financial feasibility, Public policy, Jurisdiction, Massachusetts.

Coastal zone development within the 78-community, 1,500-mile shoreline of Massachusetts receives varying degrees of environmental review through several regulatory and nonregulatory state programs. Strong regulatory and nonregulatory environmental programs in Massachusetts are providing for better protection of coastal wetland and flood plain areas through the designation of Areas of Critical Environmental Concern (ACEC), primarily large wetland systems bordered by relatively undeveloped upland. An ACEC designation serves to formally recognize the importance of significant coastal resource systems, alerting regulatory agencies and the public alike, that any project therein must meet high environmental quality standards. In one case, development proponents selected to locate a town-house community outside of the ACEC boundaries for a combination of environmental, economic, and financial reasons that will benefit both the public and private interests. With an expanded program that addresses the multi-town jurisdiction within ACECs, protection of entire coastal watersheds can be proactive and not left to the chance that developers will design an environmentally conscious project. (See also W90-02368) (Fish-PTT)
W90-02374

CHANGES IN FLOODPLAIN MANAGEMENT PHILOSOPHY AND POLICY RESULTING FROM THE TRINITY RIVER REGIONAL ENVIRONMENTAL IMPACT STATEMENT (REIS).
Halff (Albert H.) Associates, Inc., Fort Worth, TX.
For primary bibliographic entry see Field 6G.
W90-02375

INCREASING AWARENESS AND UNDERSTANDING OF FLOOD HAZARD AREAS AND FLOOD RISKS THROUGH PRINTED MATERIALS TARGETED TO SPECIFIC INTEREST GROUPS.
Tennessee Valley Authority, Knoxville.
C. W. Goff, and P. W. Reed.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 103-108.

Descriptors: *Flood plain management, *Information systems, *Publications, *Public relations, Land use, Land development, Water resources development, Flood plain zoning, Tennessee.

In an effort to increase awareness of flood hazard areas and promote a better understanding of flood risks among private-sector decision-makers, Tennessee Valley Authority's (TVA) Floodplain Management Program (FMP) has prepared and published a series of informative brochures directed at four specific interest groups--homeowners and prospective homeowners, real estate professionals, lenders, and builders and developers. A decision was made to produce the brochures as a related series, each appealing to its targeted audience's special interests and concerns. The reader would have to readily see the benefits of awareness of flood hazard areas and flood risks. This was the real challenge in deciding content and format of each brochure. The development of the brochure series was a very rewarding experience for the FMP staff. Especially gratifying has been the response from the many state flood plain management programs and agencies who have chosen to utilize one or several of the brochures in their flood plain management programs. The response to the brochure series indicates a continuing need for public awareness efforts in flood plain management programs at all levels and TVA intends to continue to provide leadership and demonstrate innovative methods in this area. (See also W90-02368) (Fish-PTT)
W90-02379

DISSEMINATING FLOOD HAZARD INFORMATION AT THE LOCAL LEVEL: AN APPROACH FOR THE 1990S.
Baker (Michael), Jr., Inc., Alexandria, VA.
R. A. Wild.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 113-118.

Descriptors: *Flood hazard, *Flood plain management, *Data collections, *Data storage and retrieval, *Insurance, *Information systems, Computer programs, Mapping, Data interpretation, Information exchange, Interagency cooperation.

A new mechanism is proposed for achieving community awareness--development of a state-by-state data base to coordinate flood hazard information and to facilitate dissemination of that information. The National Flood Insurance Program (NFIP) was created to mitigate future flood losses and to provide protection for property owners from potential losses. The NFIP was established as a risk assessment and mapping program, and the data generated as part of this program were to be used to develop actuarial flood insurance rates and local flood plain management programs. Technological advances in the field of computer science have facilitated the cost-effective accumulation, manipulation, and transfer of data base information and the production of reports by non-computer-literate people. An inventory of Letters of Map Amendments (LOMAs) and Letters of Map Revision (LOMRs) was prepared based on fill, which is an example of the type of information that could be included in the comprehensive data base. The inventory was developed as information that could be merged into the digital street address system being investigated by the Federal Emergency Management Agency (FEMA). In the future, some additional mechanisms will be developed for identifying, compiling, and disseminating available flood-hazard-related information to be included in the proposed comprehensive data base of flood hazard information from federal, state, and local sources. At the discretion of FEMA, the data bases will be compiled in the following order: (1) LOMRs not based on fill; (2) physical map revisions; and (3) federal insurance studies. (See also W90-02368) (Fish-PTT)
W90-02380

DEVELOPING APPROACHES AND USES OF TYPOLOGIES FOR COMMUNITY LOCAL FLOOD WARNING SYSTEMS.
River Services, Inc., Brookeville, MD.
C. B. Barrett, and S. A. Davis.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 119-127, 2 fig, 3 ref.

Descriptors: *Flood plain management, *Flood forecasting, *Warning systems, *Community development, Hydrologic properties, Economic evaluation, Social aspects, Political aspects, Interagency cooperation, Flood damage, Case studies, Surveys, Computer models, Evaluation.

The U.S. Army Corps of Engineers has taken on an expanded role in the design and implementation of local flood warning-response systems (LFWS). An evaluation procedure was needed along with an empirical base of clearly defined variables that indicates how well communities responded with and without local warning-response systems. The first stage of this work was the establishment of a warning-response system typology, broad enough to cover all possible system configurations. The typology allows a community or an agency to select a warning-response system based on four major criteria: potential lead time, accuracy, specificity of the warning message, and reliability. Since

each community is unique and will have unique flood problems, unique solutions must be utilized. Selecting an appropriate local flood warning system or service for a community requires three levels of analysis: hydrologic, economic, and sociopolitical. The Corps research program will offer a number of resources that should be useful for communities planning their own system as well as for formulating and evaluating federal projects. The primer will be followed by a series of case studies, which will be post-flood surveys of (1) actions of federal, state, and local agencies, as well as businesses and individuals; and (2) the economic and human costs of flooding. The next step will be the creation of a simple computer model that can be used for evaluating the benefits of LFWSs. Finally, it is important that agencies at all levels--federal, state, and local--share their experiences. (See also W90-02368) (Fish-PTT)
W90-02381

INTEGRATED LOCAL FLOOD WARNING SYSTEM: A LOOK AT THE FLOOD RESPONSE SYSTEM.
Oak Ridge National Lab., TN.
D. M. Neal, and R. Lee.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 128-133, 6 ref.

Descriptors: *Flood warning systems, *Flood plain management, *Warning systems, *Flood forecasting, Social participation, Networks, Communication, Decision making, Disasters, Cost analysis, Alternative planning.

Local flood warning systems are instituted and maintained at a local level. They consist of two parts: (1) the flood forecast system, and (2) the flood response system. The flood forecast system is primarily built around the technology used to predict flooding. The flood response system focuses upon the social and organizational response part of the local flood warning system. Two points about local flood warning systems are stressed. First, the system must be integrated. Second, some important organizational characteristics should be improved when developing a local flood response system. Five criteria are outlined for determining the overall effectiveness of a response system: experience, networks, communication, decision making, and everyday/disaster task overlap. Emphasis is placed on recommendations that are low cost and that can be integrated into already existing local government or emergency planning mechanisms. By improving upon experience (flood or disaster experience, exercises and drills, and planning) and networking (open-houses or meetings), the whole flood response system can be effectively, efficiently, and inexpensively improved. A state-of-the-art flood forecast system can be rendered useless by a poor flood response system. Developing and maintaining an effective flood response system is just as important as installing and maintaining an effective flood forecast system. (See also W90-02368) (Fish-PTT)
W90-02382

ANATOMY OF LOSSES TO STATE AND LOCAL GOVERNMENT PROPERTY FROM NATURAL DISASTERS.
North Carolina Univ., Chapel Hill. Center for Urban and Regional Studies.
For primary bibliographic entry see Field 6B.
W90-02386

SUBSTANTIAL IMPROVEMENT: EXISTING PROBLEMS AND POTENTIAL SOLUTIONS.
Federal Emergency Management Agency, Washington, DC.
A. T. Davison.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 173-178.

Descriptors: *Flood plain management, *Floodproofing, *Flood damage, *Flood protection, Structural engineering, Economic evaluation, Government supports, Regulations.

Most flood plain managers recognize substantial improvement as a fundamental flood plain management tool contained in the National Flood Insurance Program regulations. The problems related to substantial improvement, and the potential solutions to these problems, have been discussed and scrutinized for $>$ 10 yr. The Federal Emergency Management Agency is currently evaluating all aspects of the substantial improvement definition and its implementation at the local level. From this evaluation, proposed recommendations for making substantial improvement a more effective flood plain management tool will be prepared. An overview of previously identified problems and potential solutions is presented. Specific problems (cumulative improvements, market value, definition clarification, definition language, more restrictive requirements, cosmetic rehabilitations, and post-flood assistance) and some solutions are identified. If made more effective, substantial improvement, through an attrition process, can help promote the retrofitting and protection of many structures. (See also W90-02368) (Fish-PTT)
W90-02388

FLOOD-RESISTANT CONSTRUCTION STANDARDS IN THE NATIONAL MODEL BUILDING CODES.
Federal Emergency Management Agency, Washington, DC.
M. G. Mahoney.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 179-182.

Descriptors: *Flood plain management, *Building codes, *Floodproofing, *Flood damage, *Design standards, Interagency cooperation, Construction methods, Legal aspects, Ordinances, Regulations.

The nation's flood plains continue to be the site of significant amounts of both new construction as well as the repair or rehabilitation of existing buildings. In either case, in order for the National Flood Insurance Program (NFIP) to accomplish its goal of reducing the nation's flood losses, the Federal Insurance Administration (FIA), which is the portion of the Federal Emergency Management Agency (FEMA) that is responsible for administering the program, must encourage building practices that minimize damage to buildings located in flood-prone areas. FEMA has undertaken an effort to incorporate flood damage resistant design standards into the nation's three model building code groups: the Building Officials and Code Administrators National Building Code, the Standard Building Code, and the Uniform Building Code. FIA's approach to this process has involved either working directly with the code organization or closely coordinating with state and local officials to submit the code change proposals. An update is given of the most recent efforts involving this task. Future efforts of FEMA will center around continuing efforts to work with the model code groups or other interested parties to place as much of the NFIP flood plain management standards as possible into the model building codes. (See also W90-02368) (Fish-PTT)
W90-02389

FLOOD DEPTH AS A CRITERION FOR CONTROLLING FLOODPLAIN DEVELOPMENT.
Dewberry and Davis, Fairfax, VA.
P. W. McDermott.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 183-188.

Descriptors: *Floodways, *Flood plain management, *Flood plain zoning, *Nonstructural alternatives, *Community development, *Water depth, Velocity, Land use, Spillways, Urban planning, Resources development, Optimum development plans, Texas.

Regulatory floodways have been a source of concern to community officials. The conventional floodway development for Brazoria County, Texas, resulted in extremely wide floodways (up to five miles) and incorporated some of the prime developable land. The communities greatly desire a floodway scheme that would permit future development on the higher ground located in the flood plain. Based on scientific and historical flood data, it was concluded that water depths of over three feet and water velocities greater than three feet per second would cause hazards to human life. An evaluation was made of the filling of overbank areas in the flood plain that would have a flooding depth during the 100-year flood of three feet or less. If the resulting surcharge, during the 100-year flood, exceeded one foot, then lesser flooding depths were examined until a flooding depth was determined that would yield a surcharge no greater than one foot. The use of depth criterion is envisioned by the Federal Emergency Management Agency as providing Brazoria County with a means of implementing sound flood plain management without designating a floodway. If land less than the specified depths below the base flood elevations is developed, then it has been predetermined that that action will cause less than a one-foot surcharge. Brazoria County is the first area to be allowed the use of depth criterion. If good flood plain management is practiced by each community and the depth criterion proves to be a worthwhile technique, other communities may apply for its use in their flood plains. (See also W90-02368) (Fish-PTT)
W90-02390

RIVERINE SOFTWARE.
Pikes Peak Regional Building Dept., Colorado Springs, CO.
D. Bunting, and D. Gore.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 189-194.

Descriptors: *Flood plain management, *Computer programs, *Permits, *Nonstructural alternatives, *Community development, River basin development, Field tests, Training, Education, Data processing, Colorado.

The Riverine Floodplain Development Permit Software System was developed through a cooperative effort between the Federal Emergency Management Agency Region VIII, the Pikes Peak Regional Building Department in Colorado Springs, Colorado, and the Colorado Water Conservation Board. Riverine software is intended to address both operational and educational issues. The Riverine Floodplain Development Permit Software System provides local governments with a systematic flood plain development permit process, current information on National Flood Insurance Program flood plain management concepts and standards, and a process for maintaining flood plain development permit records. Riverine's design for wide accessibility and application could provide significant operations and educational benefits to communities beyond the Pikes Peak Region. Distribution and field testing should commence immediately to identify opportunities for improving the system and to clarify further issues relating to distribution, training, updating, and technical support. (See also W90-02368) (Fish-PTT)
W90-02391

MULTI-OBJECTIVE DECISION CRITERIA FOR ASSISTING LOCAL OFFICIALS IN MITIGATION PLANNING.
Mitigation Assistance Corp., Boulder, CO.
C. Philipsborn, and D. Barbee.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 197-202.

Descriptors: *Flood plain management, *Flood damage, *Decision making, *Community development, *Administrative decisions, Social aspects, Political aspects, Legal aspects, Economic aspects, Feasibility studies, Management planning, Urban planning, Negotiations.

Local officials faced with the burden of managing flood damage recovery and reduction should be provided with a usable set of criteria that will assist their selection of appropriate mitigation tools. Flood hazard management has reached a point where communities need to use a broad set of decision criteria to promote the concurrent achievement of loss reduction and other community goals. STAPLE, an acronym familiar in the public administration profession, is a set of criteria that will help local officials evaluate and select mitigation tools from the vast array of available techniques on the basis of nonquantitative factors with which they are familiar. STAPLE stands for Social, Technical, Administrative, Political, Legal, and Economic. Each component can be utilized as a frame of reference to analyze the feasibility of a mitigation measure being considered. By establishing and using this set of decision criteria, mitigation planners can gain a realistic overview of the feasibility of each proposed measure, or combination of measures, within the community. More specifically, these criteria will help to determine where the negotiating areas (trade-offs) are among the STAPLE criteria. The initial view is that the trade-offs often tend to be between the political and social criteria and the other four. (See also W90-02368) (Fish-PTT)
W90-02392

LOCAL GOVERNMENTS LIKE NONSTRUCTURAL MEASURES TOO.
Corps of Engineers, Atlanta, GA.
S. Reitman.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 203-207.

Descriptors: *Flood plain management, *Nonstructural alternatives, *Community development, *Urban planning, Flood control, Relocation, Case studies, Economic aspects.

Nonstructural solutions to local flooding problems are always considered under existing U.S. Army Corps of Engineers policy and, where economically feasible, can become part of the plan recommended to local sponsors of our flood control studies. The sponsoring community or county derives certain benefits from entering into a joint venture with the Corps on a structural plan. Each floodplain occupant offered the chance to relocate can escape the anxiety of future flood threats to life and property. Site specific examples are cited from studies for communities in the Southeast, for which a nonstructural solution is part of the recommended plan. Rejection of nonstructural solutions usually leaves the community involved with the problem unchanged. The residents of the floodplain who are covered by the plan must be made to understand its significance. This can only be accomplished by a strong commitment on the part of community leaders working in conjunction with the Corps study team. (See also W90-02368) (Fish-PTT)
W90-02393

FLOODPLAIN MANAGEMENT THROUGH THE COMMUNITY PLANNING PROCESS IN SAN DIEGO COUNTY.
San Diego County Dept. of Planning and Land Use, CA.
C. Saipe, J. Hill, and A. J. Brown.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 208-213, 3 fig.

Descriptors: *Flood plain management, *Urban planning, *Flood plain zoning, *Floodways, *Nonstructural alternatives, *Community development, Regulations, Land use, Recreation facilities, California.

San Diego County, California, has used many tools of the planning process to provide effective flood plain management. The General Plan recently approved for the community of Ramona provides an example. During the update of the Ramona Community Plan, flood plain regulations were applied to all properties within 100-year flood plains. Moreover, staff and the planning group identified the two floodways in the Town Center as important design features that needed to be protected and enhanced. Zoning regulations were imposed on all properties traversed by the two floodways to ensure that houses and other structures will not be constructed in these areas, that the floodways would be maintained as greenbelts, that twenty feet would be dedicated as public riding and hiking trails and that the floodways would be maintained in a natural state. Flood plain management requires a full range of structural and nonstructural measures. It also requires cooperative strategies between staff from traditionally separate departments. San Diego County's community plan update program has resulted in better flood plain management due to the efforts of staff from the Departments of Public Works, Planning and Land Use, and Parks and Recreation. (See also W90-02368) (Fish-PTT)
W90-02394

REGIONAL FLOOD CONTROL PROJECTS IN HARRIS COUNTY, TEXAS.
Harris County Flood Control District, Houston, TX.
For primary bibliographic entry see Field 4A.
W90-02395

FROM HARM'S WAY: FLOOD-HAZARD MITIGATION IN TULSA, OKLAHOMA.
Tulsa, OK.
A. Patton.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 223-228, 1 fig.

Descriptors: *Flood plain management, *Land management, *Regional planning, *Regional development, Land use, Financial feasibility, Storm water, Rainfall, Flood plains, Disasters, Regulations, Channeling, Comprehensive planning, Utilities, Maintenance, Watershed management, Warning systems, Drainage programs, Oklahoma.

Some actions have been taken to reduce the potential for flooding in Tulsa, Oklahoma, in response to frequent flood disasters. Tulsa's flooding problems arise from four principal causes: freak rains, flood plain lands, flood plain building, and funding priority. The Tulsa flood plain and storm water management program has been built, brick by brick, in reaction to flood disasters. In exchange for federal flood insurance, the city pledged to enact flood plain regulations. A U.S. Army Corps of Engineers project included channelization and open space acquisition. The community developed a comprehensive storm water management program, including a service charge on city utility bills for maintenance and management, watershed regulation, accelerated master planning and capital works, and improved warning and hazard-awareness programs. More than 300 flooded homes and 200 mobile homes were cleared from ten sites. The need for improved regional planning and coordination led to drafting of regional drainage regulations. (See also W90-02368) (Fish-PTT)
W90-02396

USING DRAINAGE ORGANIZATIONS AS TOTAL RESOURCE MANAGEMENT TOOLS.
R. T. Smith, R. Baccino, and L. A. Sprague.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 229-236.

Descriptors: *Flood plain management, *Drainage programs, *Organizations, *Flood control, *Delaware, *Watershed management, Channeling, Structural engineering, Maintenance, Resources management, Taxes, Right-of-way, Conservation.

In the state of Delaware, reduction of flood hazards, flood plain management and water management are being assisted by over 200 drainage organizations, called Tax Ditch Organizations (TDOs). For flood control and flood plain management, TDOs offer a mechanism to complete watershed improvements such as channelization, flood control structures, and basic drainage-way maintenance. TDOs can provide natural resource management at a local level on a watershed basis. Organization, rights-of-way, taxation, and conservation program development powers make TDOs strong in-place watershed management tools, Since similar drainage organizations have been formed in other parts of the U.S., these organizations may also provide strong existing authorities for local watershed management. (See also W90-02368) (Fish-PTT)
W90-02397

LOSS OF OVERBANK STORAGE IN FLOODPLAIN MANAGEMENT.
Maricopa County Flood Control District, Phoenix, AZ.
G. Rodzenko, J. J. Tram, and D. S. Plasencia.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 239-247, 11 ref.

Descriptors: *Flood plain management, *Floodways, *Bank storage, *Urban planning, *Land development, Channeling, Runoff, Vegetation, Flow velocity, Flood waves, Flood flow, Watersheds, Rivers, Urbanization, Case studies, Storm water, Mapping, Legal aspects, Flood routing, Arizona.

The overbank area or floodway fringe of a flood plain is inundated only during times of flooding. Typically, the overbank has more vegetative cover than the active channel. This dense vegetation retards flow and thus causes slower velocities. The overbank area of a flood plain has two primary effects on flows; it increases the travel time of the flood wave moving downstream, and reduces the peak flood flow. The runoff generated in a watershed is routed through a river reach and delineates both the flood plain and floodway. The Flood Control District of Maricopa County, Arizona, is concerned that urbanization of the floodway fringe district, channelization of the rivers for development, and sediment-deficient water downstream of structures are causing depletion of overbank storage, incisement of the channel, and translation of the peak flows downstream. Several case studies (Kansas City, Germany, Tokyo, Chicago, Arizona) were examined to determine if Maricopa County's concern's are unique, or shared by other storm water management agencies. Flood plain mapping should assess a flood routing that would take into account a channelized or encroached flood plain. Before implementing any flood plain management program which would deviate from current Federal Emergency Management Agency guidelines, the legal ramifications of the alternative programs should be assessed. (See also W90-02368) (Fish-PTT)
W90-02398

LIVING WITH FLOODPLAINS: LAND DEVELOPMENT IN ARIZONA.
Cella Barr Associates, Tucson, AZ.
M. S. Pearthree, and J. S. Wise.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 260-267, 1 fig.

Descriptors: *Flood plain management, *Land development, *Water resources development, *Land use, Bank storage, Channel flow, Channeling, Alluvial fans, Regulations, Design criteria, Drainage systems, Bank stabilization, Wildlife habitats, Floodwater, Arizona, Arid lands.

Flood hazards in southern Arizona, where the Phoenix and Tuscon metropolitan areas are located, occur in two distinct riverine settings: (1) overbank inundation and channel meandering along major watercourses; and (2) shallow sheet flooding of alluvial fan areas and of low-lying areas dominated by braided channel systems. High population growth has necessitated rapid development of flood plain management regulatory policies and drainage design criteria. Flood plain encroach-

ment, channel stabilization, and maintenance of natural flood plain methods have been successfully employed in areas of overbank inundation and channel meandering along major watercourses. Flood plain encroachment, channel/parkway schemes, and maintenance of existing wildlife corridors and riparian habitats within flood plain regions have been successfully employed in alluvial fan areas and braided channel systems. The projects cited have been developed with the idea of managing floodwaters while enhancing existing environmental and water resources. The coordination and interaction required between the public, agencies, developers, and engineers throughout the planning and design phases of these projects were of major importance. (See also W90-02368) (Fish-PTT)
W90-02401

IMPROVED FLOODPLAIN MANAGEMENT THROUGH EROSION SETBACKS IN COASTAL AREAS.
Coastal Science and Engineering, Inc., Columbia, SC.
C. P. Jones.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 271-279, 9 ref.

Descriptors: *Flood plain management, *Erosion control, *Coastal plains, *Coastal zone management, *Land development, *Land use, Shore protection, Legislation, Cost-benefit analysis, Legal aspects, Tide lands, Storm tides, Flood protection, Flood control, Natural resources.

Setback programs can be used to regulate upland development along shorelines, for the protection of that development, and for the protection of natural resources. The specific purpose of a setback program should be clearly stated in the enabling legislation, and all aspects of the program should be tied closely to the purpose. Several important policy, operational, and technical issues should be addressed early in the development of a program to ensure that it accurately accounts for hazards and is practical, cost-effective, and legally sound. Setback programs should be sufficiently flexible to handle shoreline variability, tidal inlets, and other natural or manmade features. Ideally, their jurisdiction should cover a broad area, extending behind the area where construction is prohibited and addressing both new and existing development. A floating setback line should be employed unless a fixed setback line can be revised often; a minimum setback should be sufficient to provide protection to structures against minor storms. (See also W90-02368) (Fish-PTT)
W90-02402

CRISFIELD, MARYLAND FLOOD ALLEVIATION AND TIDAL DIKE STUDY.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
D. P. Preusch.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 280-287, 2 fig, 2 tab.

Descriptors: *Flood plain management, *Dikes, *Tide lands, *Flood control, *Maryland, *Nonstructural alternatives, *Structural behavior, Flood-control storage, Flood protection, Flood damage, Urban planning, Economic evaluation, Cost-benefit analysis, Bank storage, Sealants.

Crisfield, Maryland, a community on the eastern coast of the Chesapeake Bay, was placed on the priority flood-prone community list due to flooding problems from extreme high tides caused by the passage of hurricanes or low pressure systems with associated high winds. A technical study was conducted and analyzed to determine the adequacy of an existing tidal dike in the Crisfield area. A list of possible structural and nonstructural alternatives was developed and a screening criteria applied to each in order to eliminate marginally effective alternatives. Structural alternatives were not economically favorable; the most cost-effective nonstructural improvement was sealants/closures. Floodwalls and other nonstructural improvements may be cost-effective and need to be assessed on a case-by-case basis. The economic analysis supports the conclusion that justification of flood alleviation projects in the Crisfield area will be difficult. (See also W90-02368) (Fish-PTT)
W90-02403

ANALYSIS OF A HIGH-HAZARD FLOOD ZONE.
Love (David J.) and Associates, Inc., Boulder, CO.
For primary bibliographic entry see Field 2E.
W90-02409

USER REQUIREMENTS ANALYSIS PRIOR TO IMPLEMENTING A GIS.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
For primary bibliographic entry see Field 7A.
W90-02411

6G. Ecologic Impact Of Water Development

RESOURCE POLICY IN THE EVERGLADES AGRICULTURAL AREA: A HISTORICAL AND ECONOMIC PERSPECTIVE.
Florida Univ., Gainesville. Dept. of Forestry.
For primary bibliographic entry see Field 6E.
W90-01966

ENVIRONMENTAL BENEFITS OF FURTHER US HYDRO DEVELOPMENT.
Synergics, Inc., Annapolis, MD.
W. L. Rogers.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 10-11, August 1989.

Descriptors: *Hydroelectric power, *Electric power production, *Environmental policy, Carbon dioxide, Fossil fuel, Nuclear power, Environmental protection, Economic aspects, Legislation, Electric Consumers Protection Act.

Further development of the substantial remaining hydro resources in the USA has the potential to reduce carbon dioxide emissions by more than 220 Mt/year (or approximately 5 per cent of the country's total emissions). Current energy and environmental policies in the USA, however, are severely restricting progress in developing the resources available, at a time when concerns about global warming are underlining the important role which hydropower could play. Small hydro plants have almost been regulated out of existence. The environmental impacts of hydro plants can be greatly reduced through careful planning and mitigative measures, such as the construction of fish ladders or the provision of minimum flows. However, hydroelectric plants, unlike fossil fuel and nuclear fuel plants, are required to pay the full, life-cycle environmental impact costs at the outset which leaves hydropower at a disadvantage. Hydropower should be compared in the light of the true life-cycle costs to society of nuclear or fossil generation. The Electric Consumers' Protection Act needs significant amendments to ensure that the Act is living up to its name. This legislation has had the greatest detrimental effect on hydropower. Well planned hydropower development is an activity to be encouraged, and not regulated out of existence. (White-Reimer-PTT)
W90-02035

RIFT VALLEY FEVER: A PROBLEM FOR DAM BUILDERS IN AFRICA.
Blue Nile Associates, Foxboro, MA.
W. R. Jobin.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 32-34, August 1989. 6 fig, 8 ref.

Descriptors: *Human diseases, *Animal diseases, *Environmental effects, *Africa, *Mosquitoes, *Public health, *Epidemics, *Dam effects, Dam construction, Drawdown, Filarial worms, Viruses.

In October 1987, construction of new dams in West Africa triggered an epidemic of Rift Valley fever, which killed more than 200 people. It was a mosquito-borne disease which had previously struck people and livestock around the Aswan reservoir in Egypt. One theory on the mode of transmission assumes that mosquitoes of the genera Culex, Aedes, and Anopheles are the principal mosquito vectors. A second more complicated theory suggests mosquitoes must first be infected by a microscopic filarial worm that makes them susceptible to the virus, and thus rapid transmitters. A number of safety measures can be applied, including general environmental protection and monitoring of virus levels in livestock. The general environmental improvements include: shoreline modifications of the reservoir to prevent mosquito breeding; control of human settlements; good drainage; and adaptation of the dam design to allow rapid drawdown in the reservoir at critical times of the year. In addition, conditions should be provided in the reservoir to encourage populations of fish which prey on mosquito larvae, and in the years immediately before and after construction of the dam the virus levels of livestock should be monitored. For dam designers, an important feature is the provision of low level outlets in the dam which would allow for emergency drawdown of the water level to control mosquito breeding, in the event of a potential epidemic. (White-Reimer-PTT)
W90-02040

ENVIRONMENTAL IMPACT ASSESSMENT OF YANGTZE VALLEY PROJECTS.
Yangtze Water Resources Protection Bureau, Wuhan (China).
Z. Fang.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 36-39, August 1989. 2 tab.

Descriptors: *Water resources development, *China, *Environmental policy, *Environmental impact statement, *Environmental protection, Impacts, Prediction, Yangtze valley, Monitoring.

Environmental assessment practices in China consist of five basic steps: (1) impact identification; (2) impact prediction; (3) mitigation and enhancing; and (4) protective measures and monitoring programs. Following these steps environmental assessments have been carried out for most of the main existing water resources projects in the Yangtze valley, and for projects under construction or planned. Three examples are presented: Danjiangkou (existing project); Gezhouba (under construction); and Three Gorges (at planning stage). The area affected by a project is determined by the magnitude, character and location of the project. In addition to the regions directly affected by the project, effects on certain neighboring regions, on the whole basin, on a neighboring basin and even on the estuary should be considered. Other aspects to be considered include: the time frame for comparison; the catagories of environmental effects; and comparisons of conditions with and without the project. An environmental impact assessment of a proposed water resources project should consider comprehensively both beneficial and adverse effects to aid selection of the optimum alternative and propose mitigation measures. All the methods are less precise when compared with those of the so-called 'hard' sciences, but assessments can be improved by giving attention to scoping, baseline studies, and effects monitoring and by undertaking post-development audits. (White-Reimer-PTT)
W90-02041

TRICHOPTERA, AND EPHEMEROPTERA AS INDICATORS OF ENVIRONMENTAL CHANGES OF THE RHONE RIVER AT LYONS OVER THE LAST TWENTY-FIVE YEARS.
Lyon-1 Univ., Villeurbanne (France). Section of Freshwater Ecology.
P. Usseglio-Polatera, and M. Bournaud.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 249-262, September/October 1989. 7 fig, 1 tab, 50 ref.

Descriptors: *Bioindicators, *Aquatic insects, *Environmental effects, *Rhone River, *Mayflies, *Caddisflies, *France, *Regulated flow, Habitats, Reproduction, Dam effects, Sedimentation, Diversity, Populations.

Systematic light trapping was carried out in Lyon on the banks of the Rhone River from 1958 to 1982, mainly in the months of June and July. The changes in the type and abundance of the adult Tricoptera and Ephemeroptera species captured over the last 25 years were studied in relation to the perturbations sustained by the river--and thus by the larval instars. A Correspondence Analysis carried out on the monthly samples defined a first factorial axis which could represent a 'biological time' scale characterized by phases of rapid (1959-1974) or slower (1974-1982) change of the faunal communities. Five 'successive' faunal groups were defined according to the length of historical presence of each of the 88 species along this axis. The most stenoecic species seem to disappear and gradually only a small number of species whose ecological requirements are less demanding subsist. This faunal impoverishment is a consequence of the increasing uniformity of the biotope caused by continuous environmental changes mainly in flow regulation. This has led to reduction in diversity of the substratum and possibly food sources. In addition, regular flush-outs of upstream reservoirs release sediments which clog interstitial spaces over long periods and this effect has been aggravated since 1966 by the bringing into service of a dam situated just downstream from the station. It seems that a new but delicate equilibrium has been reached since 1974; this situation probably corresponds to a less stenoecic biotic community. (Author's abstract)
W90-02045

EFFECT OF AN IRRIGATION AND HYDROELECTRIC RESERVOIR ON ITS DOWNSTREAM COMMUNITIES.
Universidad Autonoma de Madrid (Spain). Dept. de Ecologia.
C. Casado, D. Garcia de Jalon, C. M. Del Olmo, E. Barcelo, and F. Menes.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 275-284, September/October 1989. 3 fig, 8 tab, 33 ref.

Descriptors: *Reservoirs, *Regulated flow, *Spain, *Aquatic populations, *Environmental effects, *Dam effects, *Reservoir fisheries, Macroinvertebrates, Diversity, Aquatic plants, Biomass, Species diversity, River Tera, Irrigation, Hydroelectric power.

The Cernadilla reservoir, located on the River Tera (northwest Spain, Duero Basin) is an oligotrophic reservoir with a capacity of more than 250,000,000 cu m and a depth of 70 m. The regulated flow pattern is characterized by higher summer flows, higher day flows than night ones, and lower weekend flows. The effects of this artificial flow regime on the stream ecosystem were evaluated by comparing the aquatic communities of an upstream station with those of three downstream stations, located at 1, 8, and 24 km from the dam. Physicochemical characteristics of the water, fish and macrobenthic communities, and macrophytes were studied at each station. Summer water temperatures were significantly lower downstream of the reservoir. Macrophyte biomass, macrobenthic diversity, and richness were reduced below the dam. The trophic structure was changed by an increase of shredders and grazers. Fishery total biomass greatly fluctuated seasonally, but was higher above the reservoir than below it. However, in spring the trout populations were higher upstream because large numbers of spawning cyprinids from the reservoir invaded upstream reaches of the River Tera and displaced resident trout populations. The overall effects of the reservoir on downstream communities can be generalized as adverse. The fisheries are more affected by stream regulation than macroinvertebrates. However, this cannot be attributed to the lack of food items because the biomass ratio benthos/fishes is quite high. Therefore, some other factors are limiting fish which have not yet been determined. (Author's abstract)
W90-02047

REVIEW OF THE EFFECTS OF WATER TRANSFERS IN THE LA GRANDE HYDROELECTRIC COMPLEX (QUEBEC, CANADA).
Societe d'Energie de la Baie James, Montreal (Quebec).
D. Roy, and D. Messier.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 299-316, September/October 1989. 5 fig, 5 tab, 33 ref.

Descriptors: *Interbasin transfers, *Canada, *Hydroelectric power, *Diversion, *Flow control, Environmental effects, Bank stability, Monitoring, Water quality, Aquatic animals, Fluctuations, Reservoirs, Quebec.

Construction of the La Grande Complex in Eastern Canada called for complete or partial diversion of six rivers with a mean annual discharge that varied from 60 to 1600 cu m/s, and the transfer of water from two adjoining watersheds (1586 cu m/s) into LaGrande Riviere. Three of these rivers with reduced flow, Eastmain (from 700 to 95 cu m/s), Opinaca (from 260 to 35 cu m/s), and Caniapiscau (from 1708 to 960 cu m/s) and the waterways with increased flows, Boyd-Sakami (from 1 to 811 cu m/s) and LaGrande Riviere (from 1760 to 3400 cu m/s) were intensively monitored from 1978 to 1988, while the others were surveyed sporadically. Very few modifications were observed compared to previous conditions in bank stability, water quality, and aquatic fauna of the affected rivers. Those modification that did occur can be explained by the water level fluctuations, the water quality of the tributaries of the residual drainage basin, and/or by the direct influence of the reservoirs. In James Bay, the areal extent of the Eastmain River and La Grand Riviere plumes varied with discharge in an exponential relation, mostly under ice cover; resources from the coastal environment had not yet undergone any major changes. Because of the very small population dwelling in the area, less than 3000 inhabitants, modifications in the hydrological regime of these rivers caused relatively few impacts. The main impacts were greater bank instability in specific locations, reduction of the thickness and ice cover on La Grande Riviere, enhancement of navigation constraints on Eastmain River, and higher mercury levels in fish related to operation of the reservoirs. (Author's abstract)
W90-02049

COMPARISON OF MACROBENTHOS IN BRAIDED AND CHANNELIZED SECTORS OF THE DROME RIVER, FRANCE.
Agricultural Univ., Wageningen (Netherlands). Dept. of Nature Conservation.
E. T. H. M. Peeters, and H. Tachet.
Regulated Rivers Research and Management RRRMEP, Vol. 4, No. 3, p 317-325, September/October 1989. 3 fig, 5 tab, 18 ref.

Descriptors: *Channeling, *France, *Aquatic insects, *Aquatic animals, *Braided streams, Embankments, Environmental effects, Diversity, Channels, Flooding, Habitats, Stability, Density.

The influence of braided pattern on macrobenthic communities was studied in the Lower Drome River. In order to limit the damage caused by extreme floods, riverside residents have built an embankment system on the floodplain between Crest and Livron. Two cross-sections were made, one in the channelized section upstream from Crest, and the other 12 km downstream from the braided section near Allex. Since chemical and biological changes due to longitudinal zonation are likely to be at a minimum 80-90 km downstream from the source, any observed changes in these parameters can be attributed to differences in channel morphology. At each cross section physical parameters were measured at 1 m intervals and macrobenthos samples were collected with a hand net. The qualitative differences between embanked and braided sections were minimal. The sessile species (i.e. Psychomyia pusilla) were more frequent in the embanked section whereas the drifting species (i.e. Baetis fuscatus) were more frequent in the braided section. The density of macroinvertebrates in the braided section, especially in the secondary channels, was higher than in the embanked section, but the diversity remained low because the location of the channels changes at each extreme flood. Thus, although production in the braided section is potentially more important than in the embanked section, spatio-temporal instability limits this production to a very short period of the year and prohibits the development of a more diversified benthic community. (White-Reimer-PTT)
W90-02050

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. I. 137CS AND 210 PB TECHNIQUES.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2J.
W90-02095

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND II. FELDSPAR MARKER HORIZON TECHNIQUE.
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 2J.
W90-02096

ABRUPT DOWNSTREAM FOREST DECLINE FOLLOWING RIVER DAMMING IN SOUTHERN ALBERTA.
Lethbridge Univ. (Alberta). Dept. of Biological Sciences.
S. B. Rood, and S. Heinze-Milne.
Canadian Journal of Botany CJBOAW, Vol. 67, No. 6, p 1744-1749, June 1989. 6 fig, 22 ref. Alberta Environmental Research Trust grant T01016.

Descriptors: *Ecological effects, *Dam effects, *Riparian vegetation, *Forests, Canada, Rivers.

The influence of river damming on the abundance of riparian poplar forests was investigated by comparing forest abundances on the dammed St. Mary and Waterton rivers of southern Alberta with the neighboring undammed Belly River. Forest distributions were determined by estimating the linear river distance of forests from airphotos taken in 1961 and 1981, both upstream and downstream from the dams. During the 20-year interval, a 48% reduction occurred downstream from the St. Mary Dam, which was completed in 1951. Downstream from the Waterton Dam, completed in 1964, riparian forests declined 23%. Poplar abundance along the downstream region of the undammed Belly River was relatively unchanged over the study period, showing less than a 1% reduction. The upstream (undammed) portions of all three rivers underwent a slight forest decline during the 20-year interval; declines of 4.7% occurred along the St. Mary, 4.6% were seen along the Belly and 6.1% occurred along the Waterton river. Thus, the damming of two rivers in southern Alberta has been followed by a rapid and dramatic downstream decline in riparian forests. Further, the close association between the location and extent of the forest decline supports a causal relationship between the river damming and the forest decline. Possible causes of the decline include drought-induced mortality, particularly of seedlings. (Author's abstract)
W90-02236

TAMING THE FLOOD: A HISTORY AND NATURAL HISTORY OF RIVERS AND WETLANDS.
Severn-Trent Water Authority, Birmingham (England).
J. Purseglove.
Oxford University Press, New York. 1988. 307 p.

Descriptors: *River training, *Drainage effects, *Wetlands, *Rivers, *Ecological effects, *Water management, Agriculture, River basin development, Marshes, Fens, Swamps, Social aspects, Economic aspects.

The agricultural revolution of the last forty years has destroyed a huge portion of flora and fauna,

and nowhere have the results been more devastating than in the wetlands--from marshes and wet meadows to ponds and river banks. This book is about the age-old battle between man and water. From the Lancashire mosses and the Derwent Ings, Otmoor and the Fens, to Romney Marsh and the Somerset Levels, the author traces the history and natural history of these rivers and wetlands, describing in vivid detail both the beauty of these ancient landscapes, and the often disastrous results of attempts to tame them. In chapters 2 and 3, the long history of river management, during which land drainage has continually been the subject of controversy, is surveyed. In the following chapters, the author questions whether wholesale drainage is always sensible in terms of practical agricultural economics and efficiency. How land drainage is done, and the way in which an activity which has been, and often still is, environmentally destructive can now be carried out to enhance the landscape quality of rivers, while still controlling their dangerous potential for flooding, is examined. In the last chapter, the case of wetlands is discussed, where it is now increasingly accepted that in the interests of the environment, major drainage should never be carried out. (Lantz-PTT)
W90-02288

DREDGING OPERATIONS TECHNICAL SUPPORT (DOTS) PROGRAM: AN UPDATE.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
T. R. Patin, and R. Baylot.
Available from the National Technical Information Service, Springfield, VA 22161. Environmental Effects of Dredging Information Exchange Bulletin, Vol. D-89-1, July 1989. 5 p.

Descriptors: *Dredging, *Environmental effects, *Regulations, *Management planning, Standards, Waste disposal, Path of pollutants, Computers, Costs.

In 1978 the Corps of Engineers established the Dredging Operations Technical Support (DOTS) Program as a technology transfer vehicle to assist the field in implementing results from research, development, and field demonstration programs. DOTS is presently managed within the Environmental Effects of Dredging Programs (EEDP). The focus of DOTS is a complete dredged material management approach. As environmental management becomes a rroutine part of field applications, the Corps faces new disposal management decisions brought on by more environmentally complex problems and regulations. Based on these changing field needs, recommendations from the Chief of Engineers' Environmental Advisory Board, and guidance from the field, a complete Dredged Material Management structure guides the assessment and technical application tasks of the DOTS Program. These 'tasks' are generally one-or two-year efforts aimed at developing practical 'hands-on' field guidance on existing technology as opposed to research efforts that are concerned with developing the technology. The DOTS focus has two objectives: to continue to address the field's high priority technology application needs, and to oversee the application of a complete long-term management strategy for evaluating and assessing various dredged material disposal alternatives. The following are the eleven high priority tasks pursued in fiscal year 1989: Automated Dredging and Disposal Alternative Management System (ADDAMS) (FY 87-90); Guidelines for Biological and Physical Monitoring of Aquatic Disposal (FY 87-89); Beneficial Uses of Dredged Material--Applications in Coastal Open-Water Habitats (FY 88-90); Seasonal Restrictions on Dredging (FY 87-89); Optimization of Dredging and Dredged Material Disposal (FY 87-89); Decisionmaking Framework Application Software (FY 89-90); Framework for Comprehensive Analysis of Migration Pathways (CAMP) in Confined Disposal Facilities (FY 89-90); Beneficial Uses of Dredged Material--Stabilization of Dredged Material Shorelines with Wetland Vegetation in Moderate Wave Energies (FY 87-89); Beneficial Uses of Dredged Material--Application in Large Inland Waterways (FY 88-90); Dredged Material Chemical Testing Cost Reduction (FY 87-89); and Guidelines for Long-Term Management Strategies of Dredged Material Disposal (FY 88-90). (Lantz-PTT)
W90-02294

HYDROLOGIC EFFECTS OF THE 1984 THROUGH 1986 L-31 CANAL DRAWDOWNS ON THE NORTHERN TAYLOR SLOUGH BASIN OF EVERGLADES NATIONAL PARK.
Everglades National Park, Homestead, FL. South Florida Research Center.
R. A. Johnson, J. I. Wagner, D. J. Grigsby, and V. A. Stern.
Available from the National Technical Information Service, Springfield, VA 22161, as PB89-120893. Price codes: A04 in paper copy, A01 in microfiche. Report SFRC-88/01, 1988. 45p, 10 fig, 5 tab, 19 ref, 3 append.

Descriptors: *Canals, *Surface-groundwater relations, *Drawdown, *Environmental effects, *Florida, *Everglades, *Wetlands, Water level, Rainfall, Seasonal variation, Frog Pond, Hydraulic structures, Hydraulic profiles, Agriculture, Canals, Taylor Slough.

Hydrologic investigations were conducted by the National Park Service to evaluate the impacts (from 1984 through 1986) of the L-31W canal drawdown operations on the water resources of the northern Taylor Slough basin of Everglades National Park. These hydrologic investigations indicate that the L-31W canal agricultural drawdown operations produced water level reductions throughout northern Taylor Slough, particularly in the areas adjacent to the L-31W canal. All of these drawdowns occurred during years when the total annual rainfall was $>$ 10 inches below normal and monthly total rainfall during the September through November study periods was also below normal. The overall results of this study indicate that management of wet season stages below 4.50 feet in the upper portion of the L-31W canal causes drainage of the adjacent Taylor Slough wetlands. Review of water level data collected during the last 4-1/2 years of the Frog Pond drawdown study indicate that during the months of June through November, L-31W canal stages generally remained well below the stage in the Taylor Slough wetlands. Under these conditions, the L-31W canal acts as a groundwater sink draining the adjacent wetlands. This is inconsistent with the initial design purpose of the L-31W canal which states that the canal should replenish the fresh water supply to the Taylor Slough basin. The lowering of L-31W canal stages to allow earlier land preparation and planting in the Frog Pond agricultural area further exacerbates the drainage effects of the canal system and is incompatible with the system design intent of restoring fresh water flows to the Taylor Slough basin. (Lantz-PTT)
W90-02305

CHANGES IN FLOODPLAIN MANAGEMENT PHILOSOPHY AND POLICY RESULTING FROM THE TRINITY RIVER REGIONAL ENVIRONMENTAL IMPACT STATEMENT (REIS).
Halff (Albert H.) Associates, Inc., Fort Worth, TX.
T. L. Lovell, R. S. Griffith, and R. Killen.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 73-78, 1 fig, 2 tab, 4 ref.

Descriptors: *Flood plain management, *Regional planning, *Environmental impact statement, *Regional development, *Community development, Long-term planning, Structural engineering, Nonstructural alternatives, Flood protection, Permits, Valley storage, Channeling, Flood control, Flood plain zoning, Habitats, Remote sensing, Environmental engineering, Texas

The Fort Worth-Dallas, Texas Metroplex, lies in the upper Trinity River basin, about 500 river miles above the Gulf Coast. Flooding has historically been one of the major natural disasters in north Texas. Flood plain management in this urban area has evolved from primarily structural features (flood control reservoirs, levees, channels) through the early 1960s, to a complex mix of structural and nonstructural measures today. In December of 1984, the Fort Worth District of the U.S. Army Corps of Engineers began preparation of a Regional Environmental Impact Statement (REIS) 'to address the cumulative impacts of development within the flood plains of the Trinity River in the Dallas-Fort Worth Metroplex.' Some conclusions of the REIS related to flooding were that: (1) widespread lack of Standard Project flood protection currently exists in the region, (2) permit strategies could have a significant impact on the degree of increase in the regional flood hazard, (3) valley storage was identified as a critical component in the permit process, and (4) when channelization is used to prevent upstream flooding, damages are likely to be transferred downstream. Several important technical analyses were conducted to assess cumulative impacts on terrestrial habitats in the flood plain using a regional perspective, developing a stronger basis on which to develop applications for state-of-the-art remote sensing technology that provide long-term spinoffs to the Corps planning process. The Trinity River REIS has had a significant impact on the development community in this region, forcing development engineers to plan and design more extensive and costly mitigation areas. (See also W90-02368) (Fish-PTT)
W90-02375

QUANTITATIVE ASSESSMENT OF THE IMPACT OF FLOODPLAIN MANAGEMENT STRATEGIES ON RESIDENTIAL DAMAGE.
New South Wales Dept. of Public Works, Sydney (Australia).
For primary bibliographic entry see Field 6B.
W90-02385

ASSESSMENT AND DEVELOPMENT--MANAGEMENT PATTERNS OF KARST WATER RESOURCES IN CHINA.
Ministry of Geology and Mineral Resources, Beijing (China). Bureau of Hydrogeology and Engineering Geology.
For primary bibliographic entry see Field 6D.
W90-02449

DISTRIBUTION OF KARST GROUNDWATER IN SOUTHERN PART OF DUSHAN, GUIZHOU PROVINCE AND ITS EXPLOITATION AND MANAGEMENT.
Guizhou Inst. of Tech., Guiyang (China).
For primary bibliographic entry see Field 2F.
W90-02456

KARST ENVIRONMENTAL EFFECT OF WATER-CONSERVANCY AND WATER-ELECTRICITY PROJECTS IN MOUNTAIN AREAS OF GUIZHOU, CHINA.
Guizhou Provincial Bureau of Water Conservancy and Electric Power, Guiyang (China).
For primary bibliographic entry see Field 4C.
W90-02458

INFLUENCE OF RESERVOIR ON EARTHQUAKES IN KARST AREA--GRANCAREVO DAM SITE.
Split Univ. (Yugoslavia). Faculty of Civil Engineering Sciences.
P. Stojic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 144-149. 4 tab, 1 ref.

Descriptors: *Reservoirs, *Earthquakes, *Yugoslavia, *Karst hydrology, *Environmental effects, *Karst, Seismic properties.

The study of effects of reservoirs in karst areas on the regime of local earthquakes uses the earthquake data from the observational seismic station at the Grancarevo Dam Site, on the Trebisnjica River, Yugoslavia. The data were analyzed for the purpose of finding the relationship between the

large Bileca Reservoir, created by this dam in a highly karstified region with a large karst aquifer, and the regime of local earthquakes. It was hypothesized that the increase of karst aquifer levels by 70-100 meters and the increased load by the reservoir and additional aquifer water storage has affected the earthquakes. It was found that the number of local earthquakes per year significantly increased in the first four years of filling and emptying of the reservoir. The reservoir has been filled with water in stages for several years, in order to avoid the sudden loading of the reservoir which might trigger a large earthquake. (See also W90-02444) (Author's abstract)
W90-02459

EFFECTS OF LAND DRAINAGE ON GROUNDWATER RESOURCES IN KARSTIC AREAS OF IRELAND.
Trinity Coll., Dublin (Ireland). Dept. of Geography.
D. P. Drew, and C. E. Coxon.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 204-209. 21 ref.

Descriptors: *Drainage effects, *Surface drainage, *Karst hydrology, *Environmental effects, *Ireland, *Groundwater depletion, Groundwater level, Groundwater movement.

The impact of land drainage on groundwater resources is particularly acute in karst areas because of the unique characteristics of karstic aquifers. Arterial drainage of karst lowlands in Ireland, involving the construction of artificial river channels, has resulted in losses of recharge, lowering of water tables, drying up of seasonal lakes (turloughs), alteration of underground flow routes and periodic groundwater contamination. (See also W90-02444) (Author's abstract)
W90-02466

SOME APPLICATIONS OF FLOOD FREQUENCY AND RISK INFORMATION IN FOREST MANAGEMENT.
Francis Marion and Sumter National Forests, P.O. Box 2227, Columbia, SC 29202.
For primary bibliographic entry see Field 2E.
W90-02525

7. RESOURCES DATA

7A. Network Design

MEASUREMENTS, DATA ANALYSIS AND CONTROL METHODS IN WASTEWATER TREATMENT PLANTS: STATE OF THE ART AND FUTURE TRENDS.
Lund Univ. (Sweden). Dept. of Industrial Automation.
For primary bibliographic entry see Field 5D.
W90-02073

APPROPRIATENESS OF AUFWUCHS AS A MONITOR OF BIOACCUMULATION.
Savannah River Ecology Lab., Aiken, SC.
For primary bibliographic entry see Field 5A.
W90-02115

BIOLOGICAL WATER QUALITY ASSESSMENT OF RUNNING WATERS BASED ON MACROINVERTEBRATE COMMUNITIES: HISTORY AND PRESENT STATUS IN EUROPE.
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
J. L. Metcalfe.
Environmental Pollution ENPOEK, Vol. 60, No. 1-2, p 101-139, 1989. 1 fig, 14 tab, 41 ref.

Descriptors: *Environmental effects, *Environmental protection, *Bioindicators, *Europe, *Water pollution effects, History, Pollution index, Diversity, Biotic index, Sensitivity, Monitoring, Water quality management.

The history and development of biological water quality assessment using macroinvertebrates in Europe, and a critical evaluation of each principal approach used is presented. The saprobic approach is based on the pollution tolerances of indicator species form all components of the aquatic fauna, but mainly bacteria, algae, protozoans and rotifers. The diversity approach uses three components of community structure--richness, evenness and abundance, to describe community response to environmental quality. The biotic approach incorporates desirable features of the saprobic and diversity approaches, combining a quantitative measure of species diversity with qualitative information on the ecological sensitivities of individual taxa into a single numerical expression which can be statistically analyzed. As the biotic approach incorporates the most highly regarded features of the saprobic and diversity approaches, it has received the most attention in recent years. Most modern biotic index and score systems have evolved from the Trent Biotic Index, through a series of refinements and adaptations into the two modern systems. These methods are the Biological Monitoring Working Party Score System, used mainly in Great Britain, and the Belgian Biotic Index Method. The results of these techniques are now influencing policy decisions concerning surface water management in Europe, where macroinvertebrate community assessments are being used as a planning tool for managing water uses, for ambient monitoring, and for evaluating the effectiveness of pollution control measures. New research directions aimed at improving the performance of bioassessment techniques are being explored. These include defining reference communities based on stream typology which can then be used to set water quality objectives, and applying these methods to the assessment of toxic pollution. (Author's abstract)
W90-02116

ESTIMATION OF SULFUR AND NITROGEN WET DEPOSITION TO THE GREAT LAKES.
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 5B.
W90-02139

BED MATERIAL SAMPLING ERROR IN SAND BED RIVERS.
University of Western Ontario, London. Dept. of Geography.
P. E. Ashmore, T. R. Yuzk, and R. Herrington.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2195-2203, October 1989. 8 fig, 5 tab, 12 ref.

Descriptors: *Sampling, *Alluvium, Bottom sampling, *Sediment sampler, *Streambeds, *River beds, Variability, Sand, Particle size, Error analysis.

A total of 468 bed material samples were collected at cross sections of the sand bed of the South Saskatchewan River at Saskatoon to assess the random and systematic errors in the results from four commonly used samplers. Statistically significant differences in particle size distribution occur between the results obtained from different samplers at the same locations, in part due to variability in retention of the small particles. The differences are greatest in silty sand and least in well-sorted, medium sand. The precision of results from repetitive samples at the same location using the same sampler depends on both the sampler and the composition of the bed material. Except in well-sorted, medium sand, a single sample at a vertical is inadequate to determine the particle size of a given size fraction within 10% with a probability of error of 0.1. In some cases 10 or more samples may be required. The magnitude of these statistical errors at a given location is generally less than the within-reach variability in bed material particle size, and therefore the appropriate choice of sample location is critical. (Author's abstract)
W90-02198

MULTIOBJECTIVE SAMPLING DESIGN FOR PARAMETER ESTIMATION AND MODEL DISCRIMINATION IN GROUNDWATER SOLUTE TRANSPORT.
Geological Survey, Reston, VA.
D. S. Knopman, and C. I. Voss.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2245-2258, October 1989. 12 fig, 1 tab, 37 ref.

Descriptors: *Network design, *Sampling design, *Solute transport, *Soil water, *Sampling, *Model studies, Costs, Design criteria, Water chemistry, Variance, Sensitivity.

Sampling design for site characterization studies of solute transport in porous media is formulated as a multiobjective problem. Optimal design of a sampling network is a sequential process in which the next phase of sampling is designed on the basis of all available physical knowledge of the system. Three objectives are considered: model discrimination, parameter estimation, and cost minimization. For the first two objectives, physically based measures of the value of information obtained from a set of observations are specified. In model discrimination, value of information of an observation point is measured in terms of the difference in solute concentration predicted by hypothesized models of transport. Points of greatest difference in predictions can contribute the most information to the discriminatory power of a sampling design. Sensitivity of solute concentration to a change in a parameter contributes information on the relative variance of a parameter estimate. Inclusion of points in a sampling design with high sensitivities to parameters tends to reduce variance in parameter estimates. Cost minimization accounts for both the capital cost of well installation and the operating costs of collection and analysis of field samples. Sensitivities, discrimination information, and well installation and sampling costs are used to form coefficients in the multiobjective problem in which the decision variables are binary (zero/one), each corresponding to the selection of an observation point in time and space. The solution to the multiobjective problem is a noninferior set of designs. To gain insight into effective design strategies, a one-dimensional solute transport problem is hypothesized. Then, a approximation of the noninferior set is found by enumerating 120 designs and evaluating objective functions for each of the designs. Trade-offs between pairs of objectives are demonstrated among the models. The value of an objective function for a given design is shown to correspond to the ability of a design to actually meet an objective. (Author's abstract)
W90-02202

USER REQUIREMENTS ANALYSIS PRIOR TO IMPLEMENTING A GIS.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
R. P. Munnikhuysen.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 343-348.

Descriptors: *Geography, *Information systems, *Flood plain management, *Geographic information systems, *Mapping, Data processing, Operating policies, Digital computers, Cost-benefit analysis, Organizations.

Successful Geographic Information Systems (GISs) consistently serve the full needs of their users. Of prime importance in the development of a successful GIS is a User Requirements Analysis (URA). The URA reviews in detail map products and other information needed by the organization. One frequently proposed use of a GIS is the production of hard-copy products that mimic traditional mapping. However, limiting GIS application to hard-copy products underutilizes the potential of this technology to analyze spatial data. A URA should, therefore, question the requirement for traditional products and investigate the organization's needs for entirely new products and services. Documentation of the URA should include the following information: operation, users, and data requirements of the existing system; the users of the

present system and potential users of a GIS; digital and hard-copy products required by users; the volume of data expected to be processed by the GIS and production rates; the data base required to support the GIS; and the cost and benefit analysis. Completion of a URA report does not finish the GIS selection effort. Hardware and software systems must be reviewed and benchmarked to determine if they meet user and URA-defined needs. (See also W90-02368) (Fish-PTT)
W90-02411

ENVIRONMENTAL ISOTOPE IDENTIFICATION OF CATCHMENT AREAS IN KARST.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
For primary bibliographic entry see Field 2F.
W90-02450

7B. Data Acquisition

SIMULATION-OPTIMIZATION ALGORITHM FOR RESERVOIR CAPACITY CALCULATION: THE EFFECT OF INFLOW DATA SET LENGTH.
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
K. D. Barlishen, S. P. Simonovic, and D. H. Burn.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 4, p 477-482, August 1989. 4 fig, 1 tab, 14 ref. Natural Sciences and Engineering Research Council of Canada Nos. OGP0004416 and OGP0006589.

Descriptors: *Reservoir capacity, *Simulation analysis, *Optimization, Algorithms, Hydrologic data, Streamflow.

A simulation-optimization algorithm for sizing potential reservoirs on a river basin has been used to demonstrate the effects of the streamflow record length on capacity requirements. The sizing procedure involves the generation of synthetic streamflows and a reservoir reliability analysis. Two levels of reliability are present: the reliability in meeting water supply requirements, and the probability level associated with the final capacity selection. The procedure was applied to synthetic sequences generated from an 81-year inflow record and subsets of this sequence to produce frequency distributions of required capacities. The capacities with a 5% probability of exceedence were compared. Relying on short inflow sequences can lead to substantial overestimations or underestimations of capacity. A key factor is the presence of the critical period in the analysis. An open question remains regarding the effect of the final probability level selection on the range of capacities observed. (Author's abstract)
W90-01982

SELF-CONSISTENCY APPROACH TO IMPROVE MICROWAVE RAINFALL RATE ESTIMATION FROM SPACE.
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
C. Kummerow, R. A. Mack, and I. M. Hakkarinen.
Journal of Applied Meteorology JAMOAX, Vol 28, No. 2, p 869-884, Sep 1989. 13 fig, 1 tab, 28 ref.

Descriptors: *Meteorological data, *Rainfall rate, *Remote sensing, *Statistical methods, Radiometry, Microwaves, Clouds.

A multichannel statistical approach was used to retrieve rainfall rates from brightness temperatures (T sub B's) observed by passive microwave radiometers flown on a high-altitude NASA aircraft. Brightness temperature statistics were based upon data generated by a cloud radiative model. This model simulates variabilities in the underlying geophysical parameters of interest, and computes their associated T sub B's in each of the available channels. By further imposing the requirement that the observed T sub B's agree with the T sub B values corresponding to the retrieved parameters through the cloud radiative transfer model, the results can be made to agree quite well with coincident radar-derived rainfall rates. Some information regarding the cloud vertical structure is also obtained by such an added requirement. The applicability of this technique to satellite retrievals was also investigated. Data which might be observed by satellite-borne radiometers, including the effects of nonuniformly filled footprints, are simulated by the cloud radiative model for this purpose. Results from statistics generated using different hydrometeor vertical profiles in the cloud radiative model were examined and it was found that errors in the retrieved rainfall rates, and retrieval biases, decrease with increasing agreement between simulated T sub B's and those corresponding to the retrieved geophysical parameters. (Author's abstract)
W90-01989

TWO AUTOMATED METHODS TO DERIVE PROBABILITY OF PRECIPITATION FIELDS OVER OCEANIC AREAS FROM SATELLITE IMAGERY.
Canadian Meteorological Centre, Dorval (Quebec).
For primary bibliographic entry see Field 2B.
W90-01990

IDENTIFICATION OF SURFACTANTS IN WATER BY FAB MASS SPECTROMETRY.
Aigues de Barcelona (Spain).
For primary bibliographic entry see Field 5A.
W90-02018

CONJUNCTIVE USE OF GEOPHYSICAL AND GEOLOGICAL DATA IN THE STUDY OF AN ALLUVIAL AQUIFER.
Nebraska Univ., Lincoln. Conservation and Survey Div.
J. F. Ayers.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 625-632, 7 fig, 1 tab, 15 ref.

Descriptors: *Geophysical methods, *Nebraska, *Aquifers, *Geohydrology, *Alluvial aquifers, Electrical soundings, Platte Valley, Model studies, Groundwater movement, Pumping, Porosity, Archie equation, Clays, Mapping.

A geoelectric survey, composed of vertical electrical soundings, was conducted over part of the lower Platte Valley alluvial aquifer of east-central Nebraska. Survey results, in conjunction with seismic-survey data and test-hole-log information, provided the basis to map the areal extent and thickness of a near-surface, low-permeability clay unit. Because of the low hydraulics conductivity of the clay, the unit forms a confining layer over a significant part of the aquifer. Generally, the approach to evaluating the lower Platte Valley alluvial aquifer for sustained yield has been to assume that the entire flow system is under water-table conditions. However, numerical-model simulations with and without the clay unit indicate that this confining layer has a significant effect on the hydraulic behavior of the groundwater flow system under pumping stresses. An estimate of the bulk porosity of the aquifer was made by using geoelectric data and applying the Archie equation. Values of porosity ranged from 0.27 to 0.43; although reasonable for fluvial sand and gravel, the range is higher than previous estimates. (Author's abstract)
W90-02019

SHAPE FACTORS FOR PERMEABILITY TESTS IN BOREHOLES AND PIEZOMETERS.
Ecole Polytechnique, Montreal (Quebec). Dept. de Genie Mineral.
For primary bibliographic entry see Field 2F.
W90-02022

SLUG TEST PACKER FOR FIVE-CENTIMETER (TWO-INCH) WELLS.
National Water Research Inst., Burlington (Ontario). Groundwater Contamination Section.
M. Priddle.
Ground Water GRWAAP, Vol. 27, No. 5, Sep/Oct 1989. p 713-714, 1 fig, 4 ref.

Descriptors: *Aquifer testing, *Pumping tests, *Packers, *Piezometers, *Groundwater level, *Hydraulic conductivity, *Slug tests, *Inflatable packers, Field tests, Wells.

Slug tests in standard two-inch piezometers are performed in every type of groundwater investigation in order to evaluate hydraulic conductivity in the subsurface. A slug test is most easily conducted using a small inflatable packer that is placed below the standing water level but above the screen. Water can be added to the standpipe or piezometer to any desired level and upon deflation of the packer, the change in head with time can be recorded. The packer described can be machined quickly and inexpensively out of readily available materials. The packer body is machined out of a 1.5 inch diameter solid PVC rod. The top cap is shaped to improve water flow around the packer when it is deflated. A 1/8-in nylon line is used for inflation. A wire line can be used for additional support when raising or lowering the packer in a well. Slug tests with this packer are best performed with a transducer to record the drop in water level. This design has been tested with pressures up to 410 kPa (60 psi). It can also be used for bail tests. (White-Reimer-PTT)
W90-02028

APPLICATION OF INFORMATION SYSTEMS AND TELEMETRY TO OPERATIONAL MANAGEMENT IN ANGLIAN WATER.
Anglian Water Authority, Huntingdon (England).
For primary bibliographic entry see Field 5F.
W90-02067

ICA: EVOLUTION IS BETTER THAN REVOLUTION.
South Staffordshire Waterworks Co., Walsall (England).
A. R. Comley.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1325-1331, 1989. 5 fig, 4 ref.

Descriptors: *Water treatment, *Instrumentation, *Automation, *Control systems, Telemetry, Expertise, Monitoring, Technology, Operating policies.

The impact of ICA (instruments, control, and automation) can cause considerable difficulties to the unknowledgeable user. In order to make maximum use of technology, it is necessary to develop a reasonable level of inhouse expertise and select equipment accordingly. At the present state of technology, the design emphasis is different for multi-site telemetry and single-site automation systems. Telemetry has a high level but fairly fixed operating system with emphasis on communication and picture building. Automation has a much more basic approach, giving a greater flexibility but with more effort required on programming. Installation of a new plant is not usually a problem, but difficulties that sometimes arise include: commissioning involving outside consultants; linking automation to existing systems; and coordination of contractors. In order to prevent unnecesary expenditure, the need for spares can be kept to a minimum by keeping to the same manufacturer. A major benefit of establishing inhouse expertise is the development of a suite of modular programs that can be reapplied as necessary. Since developing in house expertise can take some time, users should try to evolve slowly; initially attempting easy schemes. If a project is contracted out, a knowledgeable user will have a much better idea of what is required. (White-Reimer-PTT)
W90-02072

ACCRETION AND CANAL IMPACTS IN A RAPIDLY SUBSIDING WETLAND. III. A NEW SOIL HORIZON MARKER METHOD FOR MEASURING RECENT ACCRETION.
Louisiana State Univ., Baton Rouge. Nuclear Science Center.
For primary bibliographic entry see Field 2J.
W90-02097

STATISTICAL MODELLING OF WATER COLOR IN THE UPLANDS: THE UPPER NIDD CATCHMENT 1979-1987.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2K.
W90-02117

UPTAKE OF CADMIUM AND ZINC BY THE ALGA CHLORELLA VULGARIS: PART 1. INDIVIDUAL ION SPECIES.
Monash Univ., Clayton (Australia). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W90-02126

DETERMINATION OF LEAD-210, BISMUTH-210 AND POLONIUM-210 IN NATURAL WATERS AND OTHER MATERIALS BY ELECTROCHEMICAL SEPARATION.
Florida State Univ., Tallahassee. Dept. of Oceanography.
H. Narita, K. Harada, W. C. Burnett, S. Tsunogai, and W. J. McCabe.
Talanta TLNTA2, Vol. 36, No. 9, p 925-929, September 1989. 2 fig, 2 tab, 17 ref.

Descriptors: *Radioactive tracers, *Radon, *Water analysis, *Laboratory methods, *Heavy metals, *Water pollution, *Pollutant identification, *Electrochemistry, Bismuth, Lead, Radioisotopes, Polonium, Geochemistry.

Lead-210 (half-life=22.3 yr), 210Bi (half-life=5.02 days) and 210Po (half-life=138 days) are naturally occurring radon daughters known to e useful as tracers for certain geochemical phenomena. These isotopes are also of interest as progeny of environmental radon. An improved method for determination of 210Pb, 210Bi, and 210Po in both natural waters and solid materials has been developed. Polonium-210 is spontaneously plated onto a silver disc from dilute hydrochloric acid medium. Bismuth-210 is then electro-deposited onto a platinum gauze cathode directly from the same solution, with a graphite rod as anode. Finally, lead-210 is electro-deposited from a fluoroborate medium onto the same platinum gauze, used as the anode. All three nuclides are subsequently measured by standard low-level alpha and beta counting techniques. The speed of this method (approximately 6 hours per sample after pretreatment) is a distinct advantage over existing techniques, as 210Bi must be quickly separated from 210Pb because of its 5.02-day half-life. Another advantage of this method is that the chemical form of the sample solution is suitable for use of established separation schemes for determining other decay-series isotopes (U, Th, Pa, etc.) after the three short-lived nuclides have been processed. (Ence-PTT)
W90-02135

INTERLABORATORY METHODS COMPARISON FOR THE TOTAL ORGANIC CARBON ANALYSIS OF AQUIFER MATERIALS.
Northrop Services, Inc., Ada, OK.
For primary bibliographic entry see Field 2F.
W90-02141

PHOTOACOUSTIC DETECTION OF ORTHOPHOSPHATE IN AQUEOUS SOLUTION.
Agricultural Univ., Wageningen (Netherlands). Laser Photoacoustic Lab.
D. Bicanic, W. D. Kunze, H. Sauren, H. Jalink, and M. Lubbers.
Water, Air and Soil Pollution WAPLAC, Vol. 45, No. 1-2, p 115-120, May 1989. 3 fig, 18 ref.

Descriptors: *Instrumentation, *Water analysis, *Orthophosphates, *Spectroscopy, *Measuring instruments, Photoacoustic spectroscopy, Colorimetry, Sensitivity, Lasers.

The photoacoustic spectroscopy at 633 nm wavelength of a 8 mW He-Ne laser has been used to measure the concentration of orthophosphate dissolved in distilled water. Determination is achieved through the combined use of the colorimetric molybdenum blue method with the high detection sensitivity offered by the photoacoustic technique. A concentration of 1 mmol/cu m (96 ppb) orthophosphate could readily be detected with the relatively simple experimental set-up. The sensitivity of the present system is limited by the background water signal. Considerable suppression of the background can be obtained if the frequency of the source could be modulated back and forth across the characteristic absorption frequency and lock-in signal detection at twice the modulation frequency. Additional improvements in the performance figure could possibly be achieved either by further reducing the effective volume that accommodates the liquid sample or through the use of a better cell design and novel type of transducers. The choice of another (preferably stronger source) that emits radiation at wavelengths corresponding to the maxima of orthophosphate absorption might result in further enhancement of detection sensitivity. (White-Reimer-PTT)
W90-02159

INTERPRETATION OF OSCILLATORY WATER LEVELS IN OBSERVATION WELLS DURING AQUIFER TESTS IN FRACTURED ROCK.
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2F.
W90-02191

BED MATERIAL SAMPLING ERROR IN SAND BED RIVERS.
University of Western Ontario, London. Dept. of Geography.
For primary bibliographic entry see Field 7A.
W90-02198

ISOTOPIC INVESTIGATION OF GROUNDWATER IN THE CENTRAL SAN JUAN BASIN, NEW MEXICO: CARBON 14 DATING AS A BASIS FOR NUMERICAL FLOW MODELING.
New Mexico Inst. of Mining and Technology, Socorro. Geophysical Research Center.
For primary bibliographic entry see Field 2F.
W90-02203

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ELBE RIVER SUSPENDED PARTICULATE MATTER SEPARATED ACCORDING TO THE SETTLING VELOCITIES.
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik.
For primary bibliographic entry see Field 5B.
W90-02205

DETERMINATION OF MOLYBDENUM IN ESTUARINE WATERS USING CATHODIC STRIPPING VOLTAMMETRY.
Liverpool Univ. (England). Oceanography Lab.
S. H. Khan, and C. M. G. Van den Berg.
Marine Chemistry MRCHBD, Vol. 27, No. 1-2, p 31-42, September 1989. 6 fig, 19 ref.

Descriptors: *Laboratory methods, *Water analysis, *Estuaries, *Molybdenum, *Chemical analysis, *Cathodic stripping voltammetry, Tamar River Estuary, Dissolved solids, Salinity, Seawater, England.

Cathodic stripping voltammetry was used to determine dissolved Mo in seawater. The method consists of adsorptive collection of Mo(VI)-tropolone complexes on a hanging mercury drop electrode followed by a potential scan to monitor the Mo(VI)/Mo(V) reduction peak at -0.44 V. The optimal analytical conditions include a tropolone concentration of 2 microM, a pH of 2, an adsorption potential of -0.2 V, a scan rate of 20 mV/s in a negative direction, and a pulse rate of 10/s. The limit of detection is 0.1 nM Mo when an adsorption time of 60 s is used. The peak height increases linearly with the Mo concentration up to 50 nM Mo in these conditions, and non-linearly thereafter; the linear range can be expanded by decreasing the adsorption time or by adsorption without stirring of the solution. The method is applied to the determination of total dissolved and labile Mo in the Tamar river estuary (Great Britain). The data showed a small but definite degree of non-conservative behavior to Mo throughout the estuary. Measurements of labile Mo indicated an increasing degree of association of Mo with dissolved organic material or colloidal matter with diminishing salinity. (Author's abstract)
W90-02212

SAMPLE SIZE--PARTICLE SIZE--ERROR OF SAMPLING: CONTRIBUTION TO THE ANALYSIS OF PARTICULATE BIOMASS, (PROBENGROSSE--PARTIKELGROSSEE-FEHLERGROSSE: ZUR ANALYSE PARTIKULAR GEBUNDENER WASSERINHALTSSTOFFE).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
G. Proft, and W. Rausch.
Limnologica LMNOA8, Vol. 19, No. 2, p 177-180, 1988. 2 fig, 2 tab, 13 ref. English summary.

Descriptors: *Biomass, *Sampling, *Particulate matter, *Limnology, *Error analysis, Physical properties, Particle size, Lakes.

A normalized biomass-size spectrum for lakes was constructed by Sheldon's hypothesis to evaluate the error of sampling. The correlation sample size--particle size--number of particles was calculated by statistical analysis. The largest particles of the sample were decisive for the error of sampling. Additional errors of the procedure should be correlated with the sample size and the error of sampling. (Author's abstract)
W90-02256

TURBIDITY PATTERNS IN THE DELTA WATERS OF SOUTHWEST NETHERLANDS ON THEMATIC MAPPER (TM) AND MULTISPECTRAL SCANNERS (MSS) SATELLITE IMAGES (TROEBLHEIDSPATRONEN IN DE DELTAWATEREN VAN ZW NEDERLAND OP TM EN MSS SATELLIETBEELDEN).
Begeleidingscommissie Remote Sensing, Delft (Netherlands).
J. Stronkhorst.
Available from National Technical Information Service, Springfield, VA 22161 as N88-23303/6/GAR. Price codes: A03 in paper copy, A01 in microfiche. 1986. 26p, 1 fig, 3 maps, 2 tab, 7 ref. English summary.

Descriptors: *Coastal waters, *Remote sensing, *Satellite technology, *Turbidity, *The Netherlands, Water quality control, Landsat, Data processing.

Operational water quality measuring using LANDSAT Thematic Mapper (TM) and Multispectral Scanner (MS) and image processing using the Remote Sensing Data processing system RESEDA were used in an attempt to determine the turbidity pattern in the Fore-delta, the Eastern Scheldt and the Western Scheldt (Netherlands). The results show the limitations of LANDSAT (designed for remote sensing of land) for water quality control in the delta waters with respect to spectral, radiometric, and spatial resolution. For the time being LANDSAT TM and MSS cannot be used as an operational water quality measuring system. (Author's abstract)
W90-02269

LABELING OF ALGAE AND INORGANIC SEDIMENTS WITH NEUTRON-ACTIVATABLE INDICATOR ELEMENTS AND FLUORESCENCE DYES (MARKIERUNG VON ALGEN UND ANORGANISCHEN SEDIMENTEN MIT NEUTRONENAKTIVIERBAREN INDIKATORELEMENTEN UND MIT FLUORESZENZFARBSTOFFEN).
Hanover Univ. (Germany, F.R.). Fachbereich Biologie.
E. Schulze.
Available from National Technical Information Service, Springfield, VA 22161 as DE88-770335/GAR. Price codes: A06 in paper copy, A01 in microfiche. NP-8770335, April 1986. 124p, 51 fig, 7

tab, 82 ref. English summary.

Descriptors: *Sediments, *Algae, *Fluorescent dyes, *Tracers, *Limnology, *Activation analysis, Fluorescence, Phytoplankton, Dysprosium, Europium, Erbium, Soil.

For an investigation of algae sinking characteristics in natural bodies of water, three different species (Chlorella fusca, Scenedesmus quadricauda, Nostoc variabilis) were labeled with neutron-activatable elements. The rare earths Dy, Er, and Eu, (Dysprosium, Ersium and Europium) were preferred for their rare natural occurrence and favorable activation analysis characteristics. Growth and enrichment were monitored using a method of chlorophyll fluorescence measurement which enables measurements of the chlorophyll concentration and photosynthetic activity. After sampling, the suspensions were filtered and activated with thermal neutrons in a research reactor. The indicator masses were determined by a quantitative evaluation of the gamma spectra. In parallel to these investigations, labeling with fluorescent dyes was investigated. The transport characteristics of phosphate-carrying aggregates of the coarse clay fraction, glasses containing Dy, Eu and Er were prepared and fractionated in a centrifugal ball mill to obtain an earth with near-natural grain size distribution. The applicability of the labeling and detection methods developed for the dissertation was tested in a natural environment and the limits of application and costs were determined. (Author's abstract)
W90-02277

MODELLING OF LARGE-SCALE HEAT AND CONTAMINANT TRANSPORT IN GROUND WATER. DFG RESEARCH GROUP AT THE UNIVERSITIES OF HOHENHEIM, KARLSRUHE AND STUTTGART--REPORT OF ACTIVITIES 1986/87 (MODELLIERUNG DEES GROBRAUMIGEN WARME-UND SCHADSTOFFTRANSPORTS IM GRUNDWASSER. DFG FORSCHERGRUPPE AN DEN UNIVERSITAETEN HOHENHEIM, KARLSRUHE UND STUTTGART--TATIGKEITSBERICHT 1986/87).
Stuttgart Univ. (Germany, F.R.). Inst. fuer Wasserbau.
For primary bibliographic entry see Field 5B.
W90-02278

EXPERIMENTAL AND THEORETICAL STUDIES ON MASS TRANSFER IN AN ARTIFICIAL RAIN (EXPERIMENTELLE UND THEORETISCHE UNTERSUCHUNGEN ZUM STOFFUEBERGANG AN EINEM KUENSTILCHEN REGEN).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
For primary bibliographic entry see Field 5B.
W90-02282

CONCEPT, DESIGN AND EXPERIMENTAL EVALUATION OF A RAMANVLIDAR POLYCHROMATOR FOR SIMULTANEOUS REMOTE MEASUREMENT OF CARBON DIOXIDE AND WATER VAPOR RELATIVE TO OXYGEN (KONZEPTION, AUFBAU UND EXPERIMENTELLE ERPORBUNG EINES POLYCHROMATORS FUER EIN RAMAN-LIDAR ZUR SIMULTANEN FERNMESSUNG VON KOHLENDIOXID UND WASSERDAMPF RELATIV ZU SAUERSTOFF).
GKSS - Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)
E. Voss.
Available from National Technical Information Service, Springfield, VA 22161 as TIB/B87-82099/GAR. Price codes: E14 in paper copy, A01 in microfiche. Report no. GKSS-87/E/20, 1987. 162p, 68 fig, 20 tab, 44 ref. English summary.

Descriptors: *Remote sensing, *Water vapor, *Lidar, *Instrumentation, *Carbon dioxide, *Measuring instruments, Polychromator, Wavelength separation, Optical properties, Oxygen.

For Raman lidar measurements of high concentrations of CO2 and H2O, a device was needed for wavelength separation. A polychromator specially designed for this purpose is described. Theoretical studies used for the selection of plane gratings, imaging elements, and the arrangement of the components are presented. Experiments with the optical elements are described, including extensive efficiency measurements for the ratings. The alignment and calibration procedure for the apparatus are presented in detail. The most important properties of the polychromator were measured and their dependence on several parameters was determined. The perturbation of the CO2 channel count rate was calculated, and Raman spectra for CO2, H2O and O2 were measured. The usefulness of the device was demonstrated. (Author's abstract)
W90-02283

SOME APPLICATIONS OF REMOTE SENSING OF CROP-HAIL DAMAGE IN THE INSURANCE INDUSTRY.
Illinois State Water Survey, Urbana.
N. G. Towery.
Illinois State Water Survey Report ISWS/CIRC-143/80, 1980. Circular 143. 17p, 5 fig, 1 tab, 8 ref.

Descriptors: *Hail, *Crop damage, *Remote sensing, *Insurance, Economic aspects, Aerial photography, Infrared radiation, Agriculture.

A 4-year research project was conducted on the feasibility of using aerial photography for the adjustment of crop-hail damage. The results indicate that loss assessments could not be made with sufficient accuracy (+or-10%) in individual fields. However, the photography could be used for qualitative assessment of damage. Aerial photographs are not being used by adjusters as an additional tool in the normal adjustment procedures. Infrared photography taken from 12,000 ft above ground is used to make mosaics of entire damage areas. Photographs from 6,000 ft are being used by adjusters settling individual farmer claims. Other research led to the development of mapping losses in an entire storm or field with a computer. These techniques are also being used by insurance companies as aids in their procedures. (Author's abstract)
W90-02296

DIRECTORY: LANDSAT-RELATED PRODUCTS AND SERVICES.
Earth Observation Satellite Co., Inc., Lanham, MD.
Earth Observation Satellite Co., 4300 Forbes Blvd., Lanham, MD. United States Edition, 1986. 75 p.

Descriptors: *Remote sensing, *Directories, *Satellite technology, Organizations, Landsat.

This directory was compiled as a service to the organizations listed within, and to current and new users of Landsat data as a reference guide to assist them in identifying those organizations that provide Landsat-related products and services. The listing will be updated and expanded periodically for distribution to all subscribers to the Landsat Data User Notes (approximately 10,000 recipients), at remote sensing conferences, Landsat Browse Facilities, all organizations listed in the directory and to any others who may request copies. This direcctory, which contains information on U.S. organizations only is divided into four secctions. Secction I is an alphabetical index of organizations providing Landsat-related services and products, and includes brief descriptions of each organization's business activities. Section II groups the organizations by types of products and services offered. Section III lists the more common applications of Landsat data and the organizations involved in those applications. Section IV is an alphabetical index of organizations by state. (Lantz-PTT)
W90-02297

MULTISPECTRAL REMOTE SENSING AS A FRESHWATER QUALITY SURVEILLANCE TOOL.
Massachusetts Univ., Amherst. Dept. of Geology and Geography.
D. E. Carritt.
University of Massachusetts at Amherst Water Resources Research Center Publication No. 117, May 1980. 57p, 10 fig, 2 tab, 3 ref. OWRT Project A-084-MASS, Agreement 14-34-6022.

Descriptors: *Monitoring, *Remote sensing, *Water quality control, Massachusetts, Eutrophication, Ponds, Lakes, Reservoirs, Aerial photography, Infrared imagery, Photography.

During the past two decades fresh water resource uses have increased rapidly. In Massachusetts, management tasks for state, local and private management groups, generated by rapidly expanding use of the state's approximately 2,000 lakes, ponds and impoundments presents a work load larger than can be carried out efficiently by using classical monitoring and surveillance procedures. Most human uses of fresh water resources tend to hasten the eutrophication process. The study was designed to develop efficient monitoring and surveillance procedures, through the adaptation of existing multispectral remote sensing techniques, to obtain estimates of the trophic state and its rate of change in ponds, lakes and impoundments in Massachusetts. An attempt has been made to use equipment and procedures that have minimum complexity and cost and are still consistent with the study objectives. Simple, single engine aircraft with minor modification for convenient aerial photographhy, commercially available 35 mm cameras, accessories and films, and analytical equipment using standard TV camerars and monitor coupled with a new and relatively inexpensive video processing module can produce information needed by fresh water resource management groups at cost considerably below comparable classical monitoring and surveillance procedures. The results of the study demonstrate that the eutrophic condition of ponds, lakes and impoundments, as indicated by the quantities and the rates of production of attached and emergent macroflora and free floating phytoplankton, can be derived from color and color-IR images obtained by simple cost effective, remote sensing techniques. In addition, point sources of sediments and nutrients may be located, and inventories of the intensity of many resource uses may be made. (Author's abstract)
W90-02303

STUDY OF RAINFALL SIMULATORS, RUNOFF AND EROSION PROCESSES, AND NUTRIENT YIELDS ON SELECTED SITES IN ARIZONA AND NEW MEXICO.
New Mexico State Univ., Las Cruces. Dept. of Civil, Agricultural and Geological Engineering.
For primary bibliographic entry see Field 2A.
W90-02316

MONITORING FOR ENVIRONMENTAL IMPACT.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5A.
W90-02331

RECENT ADVANCES IN HYDRAULIC PHYSICAL MODELLING.
For primary bibliographic entry see Field 8B.
W90-02358

FUNDAMENTALS OF HYDRAULIC PHYSICAL MODELLING.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-02359

MODELS FOR STUDY OF THE DYNAMIC BEHAVIOUR OF STRUCTURES IN FLOW AND WAVES.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
For primary bibliographic entry see Field 8B.
W90-02361

Group 7B—Data Acquisition

MODELS FOR STUDY OF THE HYDRODYNAMIC ACTIONS ON HYDRAULIC STRUCTURES.
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 8B.
W90-02362

DENSITY MODELS.
Bechtel Civil, Inc., San Francisco, CA.
For primary bibliographic entry see Field 8B.
W90-02363

TIDAL MODELS.
Technical Univ. of Lisbon (Portugal). Inst. Superior Tecnico.
For primary bibliographic entry see Field 2L.
W90-02364

HYBRID MODELLING AS APPLIED TO HYDRODYNAMIC RESEARCH AND TESTING.
National Research Council of Canada, Ottawa (Ontario). Hydraulics Lab.
For primary bibliographic entry see Field 8B.
W90-02365

DYNAMIC ACTIONS ON BREAKWATER (RUBBLE-MOUND AND CAISSON/COMPOSITE TYPE BREAKWATERS).
Dansk Hydraulisk Inst., Hoersholm. Ports and Marine Structures Dept.
For primary bibliographic entry see Field 8B.
W90-02366

PHYSICAL MODELLING OF LITTORAL PROCESSES.
Delaware Univ., Newark. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-02367

ENVIRONMENTAL ISOTOPE IDENTIFICATION OF CATCHMENT AREAS IN KARST.
Niedersaechsisches Landesamt fuer Bodenforschung, Hanover (Germany, F.R.)
For primary bibliographic entry see Field 2F.
W90-02450

HYDROGEOLOGICAL INVESTIGATION OF THE KARST SUBMARINE SPRINGS ON THE MEDITERRANEAN COAST OF TURKEY, BY MEANS OF REMOTE SENSING TECHNIQUE.
Hacettepe Univ., Ankara (Turkey). Dept. of Hydrogeological Engineering.
For primary bibliographic entry see Field 2F.
W90-02500

EFFECT OF DISCHARGE MEASUREMENT ON THE RESULTS OF FLOOD FREQUENCY ANALYSIS.
East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology.
For primary bibliographic entry see Field 2E.
W90-02521

ROLE OF FLOOD-FREQUENCY ANALYSIS IN THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-02543

7C. Evaluation, Processing and Publication

LAND SURFACE HYDROLOGY PARAMETERIZATION FOR ATMOSPHERIC GENERAL CIRCULATION MODELS INCLUDING SUBGRID SCALE SPATIAL VARIABILITY.
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2B.
W90-01957

NUMERICAL ANALYSIS OF THE RESONANCE POSSIBILITIES OF A HARBOR BASIN OF VARIABLE DEPTH (UNE ANALYSE NUMERIQUE DES POSSIBILITIES DE RESONANCE D'UN BASSIN PORTUAIRE DE PROFONDEUR VARIABLE).
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W90-01981

MODELING BULK ATMOSPHERIC DRAINAGE FLOW IN A VALLEY.
National Oceanic and Atmospheric Administration, Oak Ridge, TN. Atmospheric Turbulence and Diffusion Div.
For primary bibliographic entry see Field 2E.
W90-01991

FLORIDA DIATOM ASSEMBLAGES AS INDICATORS OF TROPHIC STATE AND PH.
Florida Museum of Natural History, Gainesville.
For primary bibliographic entry see Field 2H.
W90-01998

OVERVIEW OF THE TRENDS AND FUTURE DIRECTION OF INFORMATION TECHNOLOGY IN THE WATER INDUSTRY.
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 10D.
W90-02054

SYSTEM IDENTIFICATION AND CONTROL OF THE ACTIVATED SLUDGE PROCESS BY USE OF A STATISTICAL MODEL.
Kyoto Univ. (Japan). Dept. of Environmental and Sanitary Engineering.
For primary bibliographic entry see Field 5D.
W90-02057

APPLICATION OF INFORMATION SYSTEMS AND TELEMETRY TO OPERATIONAL MANAGEMENT IN ANGLIAN WATER.
Anglian Water Authority, Huntingdon (England).
For primary bibliographic entry see Field 5F.
W90-02067

TIME SERIES ANALYSES OF SUSPENDED SEDIMENT CONCENTRATIONS AT NORTH INLET, SOUTH CAROLINA.
South Carolina Univ., Columbia. Dept. of Geology.
For primary bibliographic entry see Field 2J.
W90-02091

STATISTICAL MODELLING OF WATER COLOR IN THE UPLANDS: THE UPPER NIDD CATCHMENT 1979-1987.
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2K.
W90-02117

NUMERICAL SIMULATION OF AN INTENSE SQUALL LINE DURING 10-11 JUNE 1985 PRESTORM. PART II: REAR INFLOW, SURFACE PRESSURE PERTURBATIONS AND STRATIFORM PRECIPITATION.
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 2B.
W90-02130

RELIABLE AQUIFER REMEDIATION IN THE PRESENCE OF SPATIALLY VARIABLE HYDRAULIC CONDUCTIVITY: FROM DATA TO DESIGN.
Stanford Univ., CA. Dept. of Applied Earth Sciences.
For primary bibliographic entry see Field 5G.
W90-02200

IMPLEMENTATION OF THE THREE-DIMENSIONAL TURNING BANDS RANDOM FIELD GENERATOR.
California Univ., Livermore. Lawrence Livermore Lab.
A. F. B. Tompson, R. Ababou, and L. Gelhar.
Water Resources Research WRERAQ, Vol. 25, No. 10, p 2227-2243, October 1989. 26 fig, 2 tab, 28 ref. USNRA FIN no. B8956, USDOE W-7405-Eng-48.

Descriptors: *Statistics, *Algorithms, *Model studies, *Simulation, *Mathematical models, *Stochastic process, Hypothetical studies, Rainfall, Hydraulic conductivity, Three-dimensional models.

Numerical techniques to generate replicates of spatially correlated random fields are often used to synthesize sets of highly variable physical quantities in stochastic models of naturally heterogeneous systems. Within the realm of hydrologic research, for example, such tools are widely used to develop hypothetical rainfall distribution, hydraulic conductivity fields, fracture set properties, and other surface or subsurface flow parameters. The turning bands method is one such algorithm which generates two-dimensional and three-dimensional fields by combining values found from a series of one-dimensional simulations along lines radiating outward from a coordinate origin. Previous work with two-dimensional algorithms indicates that radial lines evenly spaced about the unit circle lead to enhanced convergence properties. The same can be said for the three-dimensional models, but it is more difficult to choose an arbitrary number of evenly spaced lines about the unit sphere. The current investigation shows that the use of larger numbers of randomly oriented lines (100) can enhance the performance of the three-dimensional algorithm. This improved performance is needed to effectively simulate problems characterized by full three dimensionality and/or anisotropy in either Monte Carlo or single-realization applications. Use of a large number of lines will also reduce the presence of a distortion effect manifested as linelike patterns in the field. Increased computational costs can be reduced by employing a fast Fourier transform technique to generate the line processes. (Author's abstract)
W90-02201

ESTIMATING POTENTIAL EVAPOTRANSPIRATION: THE EFFECT OF RANDOM AND SYSTEMATIC ERRORS.
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
For primary bibliographic entry see Field 2D.
W90-02225

SAMPLE SIZE--PARTICLE SIZE--ERROR OF SAMPLING: CONTRIBUTION TO THE ANALYSIS OF PARTICULATE BIOMASS, (PROBENGROSSE--PARTIKELGROSSEE-FEHLERGROSSE: ZUR ANALYSE PARTIKULAR GEBUNDENER WASSERINHALTSSTOFFE).
Akademie der Wissenschaften der DDR, Jena. Zentralinstitut fuer Mikrobiologie und Experimentelle Therapie.
For primary bibliographic entry see Field 7B.
W90-02256

SIMPLE DOSE-EFFECT MODEL OF LAKE ACIDITY IN QUEBEC (CANADA).
Quebec Ministere de l'Environnement, Sainte-Foy. Direction de la Qualite du Milieu Aquatique.
For primary bibliographic entry see Field 5B.
W90-02261

RIVERINE SOFTWARE.
Pikes Peak Regional Building Dept., Colorado Springs, CO.
For primary bibliographic entry see Field 6F.
W90-02391

MAPPING INNOVATIONS FOR FLOODPLAIN MANAGEMENT AND ENGINEERING.

Dewberry and Davis, Fairfax, VA.
W. G. Fry.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 310-314, 2 fig.

Descriptors: *Mapping, *Flood plain management, *Hydraulic engineering, *Computer programs, Environmental engineering, Automation, Digital computers, Elevation, Graphical methods, Flood plain zoning, Hydrologic maps, Hydrologic models, Bridges, Topographic mapping.

Two potentially significant automated mapping initiatives are presented. The first is the creation of 1:50,000-scale maps. Key project steps include: (1) predigital preparation, (2) scan digitizing, (3) production of digital elevation models, (4) production of digital line graphs, and (5) production of the 1:50,000-scale map. The second effort was the development of an interactive flood plain analyses process, allowing the engineer to utilize HEC-2 flood plain models while 'viewing' the results on a CADD system. The full package is in the final packaging stages. The system will require outside data for hydrology and bridge geometry. The package is particularly useful on smaller flood plain models, where the changes can be easily identified. The system has been utilized for several flood plain analyses and found that, with a few limitations, it is a very useful tool for the hydraulic engineer. (See also W90-02368) (Fish-PTT)
W90-02406

APPLICATION OF FLOODPLAIN MANAGEMENT BY LOCAL GOVERNMENT USING GIS TECHNOLOGY.
Pinellas Park Water Management District, FL.
M. S. Lipschultz.
IN: Floodplain Harmony. The Natural Hazards Research and Applications Information Center, Institute of Behavioral Science No. 6, University of Colorado, Boulder, CO. 1988. p 321-329, 4 fig.

Descriptors: *Flood plain management, *Geography, *Water districts, *Flood plain zoning, *Information systems, Tidal floods, Storm water, Storm surges, Comprehensive planning, Concretes, Flood channels, Structural engineering, Data processing, Data collections, Computer models, Topographic mapping, Digital computers, Florida.

High tides, storm water, and coastal surges provide the primary flooding mechanisms in the Pinellas Park Water Management District. The district embarked on a comprehensive flood abatement program that included the use of concrete-lined channels and larger structures. After eight years of operation, it was evident that considerable improvement was obtained in reducing local flooding. In order to delineate these revised flood zones within the service area, the district directed its consulting engineers to develop a multipurpose Geographic Information System (GIS) from an existing hard copy flood database. The consulting engineers compiled a storm water management and flood risk database through standard data collection and modeling techniques. Realizing that there were problems in working with multiple hard copy databases, the district planned to convert existing data to one GIS database, using computer aided design technology. The Southwest Florida Water Management District began a program of conversion from their hard copy topographic maps to digitized drawing files. The district has also obtained information from the county on property lines and ownership, furnished by the tax assessor's office, which will eventually be integrated into the overlay process. (See also W90-02368) (Fish-PTT)
W90-02408

FEASIBILITY OF PREDICTING 100-YEAR FLOODWAY WIDTH AND DEPTH IN THE TENNESSEE VALLEY BY MULTIPLE LINEAR REGRESSION.
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 2E.
W90-02410

USER REQUIREMENTS ANALYSIS PRIOR TO IMPLEMENTING A GIS.
Greenhorne and O'Mara, Inc., Greenbelt, MD.
For primary bibliographic entry see Field 7A.
W90-02411

EXPERT SYSTEM FOR MIXING ZONE ANALYSIS OF AQUEOUS DISCHARGES (CORMIX1): FURTHER DEVELOPMENTS.
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W90-02428

EFFECTS OF OIL ON MARINE MAMMAL POPULATIONS: RESULTS OF MODEL SIMULATIONS.
Battelle Ocean Sciences, Duxbury, MA.
For primary bibliographic entry see Field 5C.
W90-02440

PREDICTION AND RATIONAL DEVELOPMENT AND UTILIZATION OF UNDERGROUND WATER RESOURCES IN HAIQUAN OF HUNAN PROVINCE.
The No.1 Hydrogeological and Engineering Geological Party of Hunan Province, China.
For primary bibliographic entry see Field 2F.
W90-02461

ATTEMPT TO KARST CLASSIFICATION IN SPAIN BASED ON SYSTEM ANALYSIS.
For primary bibliographic entry see Field 2F.
W90-02480

BAYESIAN FRAMEWORK FOR INFERENCE IN FLOOD FREQUENCY ANALYSIS.
Newcastle Univ. (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02511

CONFIDENCE INTERVALS FOR DESIGN FLOOD EVENTS UNDER DIFFERENT STATISTICAL FLOOD MODELS.
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 2E.
W90-02518

USE OF ADDITIONAL HISTORICAL INFORMATION FOR ESTIMATION AND GOODNESS OF FIT OF FLOOD FREQUENCY MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 2E.
W90-02519

EXTRAPOLATION ERROR IN FLOOD FREQUENCY ANALYSIS.
Zakir Husain Engineering Coll., Aligarh (India). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02520

SOME RESEARCHES ON DETERMINATION OF RETURN PERIOD FOR HISTORICAL FLOOD IN ANALYSIS OF FLOOD FREQUENCY.
Mid-South Design Institute for Hydroelectric Project, MWREP, PRC. Guitang, Changsha, Hunan, China.
For primary bibliographic entry see Field 2E.
W90-02522

FLOOD ANALYSES PERTAINING TO DESIGN OF NUCLEAR POWER PLANTS.
Stone and Webster Engineering Corp., Boston, MA.
For primary bibliographic entry see Field 2E.
W90-02524

FLOOD RISK EVALUATION OF URBAN RIVERS WITH STANDARD EQUI-RISK LINES.
Kinki Univ., Higashiosaka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02527

UNCERTAINTIES IN FLOOD PLAIN MAPPING.
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02529

APPLICATION OF SYSTEM RELIABILITY ANALYSIS TO FLOOD FORECASTING.
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02532

STOCHASTIC APPROACH TO FLOOD DAMAGES ESTIMATION.
Montreal Univ. (Quebec). Centre de Recherche de Developpment en Economique.
For primary bibliographic entry see Field 2E.
W90-02533

FLOOD DAMAGE-FREQUENCY ANALYSIS OF AN URBANIZING WATERSHED.
Louisville Univ., KY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02535

FLOOD RISK BIAS ANALYSED THROUGH A MULTI-STATE FLOOD INSURANCE MODEL.
Victoria Dept. of Water Resources, Armadale (Australia).
K. C. Tai.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 395-404, 5 tab, 4 ref.

Descriptors: *Flood insurance, *Insurance, *Model studies, *Flooding, *Flood frequency, *Frequency analysis, *Statistical analysis, Flood hazard, Economic aspects.

Flood risk bias introduced through the traditional method of flood frequency analysis can distort the assessment of flood insurance premiums, the fair actuarial rate of flood insurance, even though the insurance payout is maintained the same. The extent of this statistical bias is examined through the concept of expected probability analysis. To assist in the analysis of flood risk bias, a multi-state insurance model is developed based on some of the basic assumptions of the previously developed two-state insurance model. The multi-state model used the multi-stage analysis of segmental probability for flooding and non-flooding at each given stage interval. An actuarial fair rate of flood insurance for each stage interval can be established, based on the ratio of the segmental probability of flooding and non-flooding. The actuarial fair rate is a pure rate of insurance. (See also W90-02507) (Author's abstract)
W90-02536

BUREAU OF RECLAMATION USE OF RISK ANALYSIS.
Bureau of Reclamation, Denver, CO.
N. F. Parrett.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 411-428, 7 fig, 2 tab.

Descriptors: *Risk analysis, *Safety, *Dam safety, *Dam design, *Hydraulic structures, *Risks,

*Maximum probable floods, Design floods, Hydrology, Flood hazard, Statistical analysis.

The Bureau of Reclamation's philosophy and methodology in using risk-based analysis to select appropriate actions in its safety of dams program is presented. Actual failures of modern major dams result most often from causes other than floods, usually piping, and usually resulting from a condition not detected by the designers before the failure. The Bureau's programs for design of dams and assessing existing dams strive for balance in assessing the several loading events that may threaten a dam. Due to additional stream flow data in most basins and revised procedures for developing the probable maximum flood (PMF), virtually all dams require a new PMF to be prepared. The application of risk analysis has been in the areas of hazard assessment, impacts of alternative actions and comparisons of hazard, and other identified factors for a risk management decision. Two hypothetical case studies are used to illustrate the Bureau's application of its philosophy: one case indicates a small incremental difference in population at risk and estimated loss of life for inflow flood levels above 60% of the maximum discharge and significant incremental property damages for all flood levels with a failure of dam potential and the second case illustrates a situation in which the incremental estimated loss of life is significant for all flood levels up to the PMF. (See also W90-02507) (Stoehr-PTT)
W90-02538

TVA PRACTICE IN FLOOD FREQUENCY AND RISK ANALYSIS.
Tennessee Valley Authority, Knoxville. Flood Protection Branch.
For primary bibliographic entry see Field 2E.
W90-02539

NUCLEAR REGULATORY COMMISSION USE OF FLOOD RISK ANALYSES.
Nuclear Regulatory Commission, Washington, DC.
For primary bibliographic entry see Field 2E.
W90-02540

FLOOD RISK ANALYSIS FOR THE NATIONAL FLOOD INSURANCE PROGRAM.
Federal Insurance Administration, Washington, DC.
For primary bibliographic entry see Field 2E.
W90-02541

NATIONAL WEATHER SERVICE ROLE IN FLOOD FREQUENCY AND RISK ANALYSIS.
National Weather Service, Silver Spring, MD. Water Management Information Div.
For primary bibliographic entry see Field 2E.
W90-02542

ROLE OF FLOOD-FREQUENCY ANALYSIS IN THE U.S. GEOLOGICAL SURVEY.
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W90-02543

8. ENGINEERING WORKS

8A. Structures

ANALYSIS OF FLEXIBLE DRAINS IN CHANGI RECLAMATION.
National Univ. of Singapore. Dept. of Civil Engineering.
G. P. Karunaratne, S. A. Tan, S. L. Lee, and V. Choa.
Canadian Geotechnical Journal CGJOAH, Vol 26, No. 3, p 401-417, August 1989. 16 fig, 15 ref.

Descriptors: *Drains, *Subsoil drains, *Soil water, *Subsurface drains, Vertical drains, Singapore, Soil physical properties, Surcharge, Pore pressure.

Vertical drains and surcharge were used to accelerate the consolidation of soft marine clay under the second runway at the Changi Airport site. To study this problem further, the consolidation of a strip of layered clay deposit under a large reclamation is analyzed as a two-dimensional problem in accordance with Biot's theory using the finite difference method. The soil with vertical drains is replaced with an equivalent soil having an enhanced vertical hydraulic conductivity obtained by equating the surface settlement of the real soil with that of the equivalent soil. The soil modulus and the hydraulic conductivity of the real soil are varied with the prevailing effective stress in the soil. The operating soil parameters determined by back analyzing the field observations in a pilot test were then utilized to predict the behavior of the main works. Soil displacement at any point in the plane of strain could be determined within a reasonable accuracy. As the equivalent soil is obtained by equating the average degree of consolidation, pore pressures cannot be predicted accurately within the drain area. However, the trend of pore pressure variation across the test site is implied by the analysis. The trend showed that pore pressures outside the drain area are found to influence the settlement and pore pressure inside the drain area, causing retardation in the consolidation of the drain area. (Author's abstract)
W90-01960

DESIGN AND PERFORMANCE OF THE CAT ARM DAMS AND TUNNELS.
Golder Associates, Inc., Atlanta, GA.
R. W. Humphries, and R. C. Connors.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 12-16, August 1989. 6 fig, 8 ref.

Descriptors: *Dams, *Hydroelectric plants, *Tunnels, *Newfoundland, Dam design, Dam construction, Tunnel construction, Tunnel hydraulics, Economic aspects, Piezometers, Settlement monuments, Seepage weirs.

The Cat Arm hydroelectric development in northern Newfoundland consists of ten dams, three tunnels, and a 127 MW powerhouse. It is the third highest head project in Canada, and incorporates a number of unusual and innovative features such as: a power tunnel with gradients as steep as 20 per cent; unlined tunnels; rock support based on the principle of design-as-you-go; haul distances of up to 60 km for impervious dam materials; and state-of-the-art filter design for the dams. The performance of the dams since filling has been monitored by piezometers, settlement monuments and seepage weirs. All piezometric levels, seepage flows and settlement amounts have been less than expected, except at one dam. The unlined diversion tunnel passed a flow of 300 cu m/s with an average velocity of 9 cu m/s. The performance of the tunnel was flawless, except for minor plucking of small blocks of rock. The forebay tunnel has been submerged since the first reservoir filling, but hydraulic losses are normal and there is no reason to suspect any problems. The dams and tunnels have performed well in the four years since they were completed and have given confidence in the design features used and demonstrated the economical aspects of the design-as-you-go method for rock support. (White-Reimer-PTT)
W90-02036

INTEGRATED ANALYSIS OF DEFORMATION SURVEYS AT MACTAQUAC.
New Brunswick Univ., Fredericton. Dept. of Surveying Engineering.
For primary bibliographic entry see Field 8F.
W90-02037

SIPHON INTAKES FOR SMALL HYDRO PLANTS IN CHINA.
Hangzhou Regional Center For Small Hydropower (China).
For primary bibliographic entry see Field 8C.
W90-02042

MARINE TREATMENT.
Acer John Taylor Ltd., London (England).
For primary bibliographic entry see Field 5E.
W90-02089

PALMIET PUMPED-STORAGE SCHEME BEGINS DUAL-ROLE OPERATION.
Electricity Supply Commission, Johannesburg (South Africa). Hydro and Water Supply Engineering Div.
For primary bibliographic entry see Field 8C.
W90-02128

PROTOTYPE EVALUATION OF BAY SPRINGS LOCK, TENNESSEE-TOMBIGBEE WATERWAY, MISSISSIPPI.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
R. G. McGee.
Available from the National Technical Information Service, Springfield, VA 22161, as ADA212431. Price codes: A05 in paper copy, A01 in microfiche. Technical Report HL-89-15, August 1989. Final Report. 82p, 18 fig, 8 tab, 20 plates, 11 ref, append.

Descriptors: *Hydraulic models, *Locks, *Tennessee-Tombigbee Waterway, Bay Springs Lock, Mississippi, Hydraulic properties, Cavitation, Fluid mechanics, Performance evaluation, Model studies, Prototypes tests, Navigation.

Prototype tests were conducted to comprehensively evaluate the performance of the 84-ft-lift Bay Springs Lock, located at the southern end of the Divide Section of the Tennessee-Tombigbee Waterway. The evaluation included analysis of the operating characteristics and hydraulic efficiency of the lock as well as a comparison of the physical and analytical model results with the prototype. Prototype measurements included pressures in the culvert system, air vent flow rates, downstream approach canal surges, valve movement and cylinder pressures, and water-surface elevations. Results indicate that satisfactory operating conditions exist at Bay Springs Lock. The lock has functioned without major operational problems and the prototype test data do not indicate any area in which operational problems might be expected. Air venting just downstream of all valves is required to eliminate large-scale cavitation. Small cavitation occurs following the vented periods; however, the time duration is so short that the design is acceptable. The 6-in. orifices installed on the filling valve air intakes for controlling air entrainment seemed to be the optimum size. Venting without the intake orifice installed (12-in.-diam opening) resulted in unacceptable chamber water-surface conditions due to the large amount of air entrained in the flow. Without venting, severe cavitation occurred. A 4-ft surge was generated in the downstream canal during normal emptying operations. Comparison of the prototype with the previous physical model studies and an analytical model showed reasonable agreement between predicted conditions and actual conditions. As expected, the physical model was less efficient than the prototype. Predictions of critical culvert pressures (below the valves) were higher than those measured in the prototype. The analytical model, when calibrated with operation time, more closely predicted these critcial pressures. Prototype values for surge height were higher than the results for the physical and analytical models. (Author's abstract)
W90-02291

DURABILITY OF BITUMINOUS-LINED CORRUGATED STEEL PIPE STORM SEWERS (APPENDICES).
Pirnie (Malcolm), Inc., Columbus, OH.
For primary bibliographic entry see Field 5D.
W90-02299

CLOVER FORK TUNNEL DIVERSION PROJECT, HARLAN, KENTUCKY: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
S. K. Martin.
Available from the National Technical Information

Service, Springfield, VA 22161. Technical Report HL-89-18, August 1989. Final Report. 50p, 8 fig, 3 tab, 13 photos, 16 plates, 6 ref.

Descriptors: *Flood protection, *Hydraulic structures, *Tunnels, *Diversion structures, Kentucky, Detritus, Hydraulic models, Clover Fork Tunnels, Bypass channels.

A tunnel diversion project has been authorized that will divert the full flow of the Clover Fork near Harlan, KY, to an outlet downstream of the city. The project has a diversion structure at the upstream end of the project that will direct the flow of the Clover Fork into four inverted U-shaped tunnels that average 1,936 ft in length. The narrow floodplain upstream of the project site is filled with debris that could potentially reach the entrance to the tunnels during the Standard Project Flood (SPF). A 1:30-scale physical model was constructed to assess the tunnel entrance for the improvement of hydrodynamic conditions and the mitigation of potential floating debris problems. A 2-dimensional depth-averaged numerical hydrodynamic model was used in conjunction with the physical model to screen alternatives that would streamline the approach. The physical model investigated these alternatives for their capability to pass debris by reproducing the SPF hydrograph while simultaneously introducing predicted volume of scaled debris. Features reproduced in the physical model included about 2,000 ft of the natural channel upstream of the tunnel entrance, the diversion structure, the proposed tunnel entrance, and 450 ft of the tunnels. The testing resulted in two entrance designs that not only passed the SPF flow with debris but also provided sufficient freeboard along the diversion structure. (Author's abstract)
W90-02306

DESIGN AND CONSTRUCTION TECHNIQUES FOR THE FUTURE.
Land and Marine Engineering Ltd., Bebington (England).
For primary bibliographic entry see Field 5E.
W90-02333

MODELS FOR STUDY OF THE HYDRODYNAMIC ACTIONS ON HYDRAULIC STRUCTURES.
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 8B.
W90-02362

ARTIFICIAL UNDERGROUND RESERVOIRS IN THE KARST EXPERIMENTAL AND PROJECT EXAMPLES.
Energoprojekt, Belgrade (Yugoslavia).
P. T. Milanovic.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 76-87. 5 fig, 2 ref.

Descriptors: *Underground storage, *Underground reservoirs, *Karst, *Reservoirs, *Reservoir construction, *Karst hydrology, *Yugoslavia, Groundwater barriers, Geological surveys, Underground dams.

Artificial underground storage can be realized by watertight geotechnical construction into the karstified rock massif, behind the spring, or on the surface in front of the spring. It is impossible to establish a universal model of geological structure suitable for artificial groundwater storage. The crucial parameters of artificial groundwater storage are: geological structure, i.e. the position of different hydrogeological units; recent stage of karst aquifer evolution, i.e. the parameters of base groundwater flows; the parameters of aquifer hydrogeological contours; storage capacity of karst aquifer hydrogeological contours; maximum possible underground backwater level and position of underground dam construction. Using a few small scale experiments (plugging of individual underground karst channels) and long-term investigations and monitoring of a large karst aquifer the feasibility study for project Ombla was completed. It was recommended that the underground dam Ombla, near Dubrovnik, Yugoslavia should be constructed to regulate the karst spring discharge (4-120 cubic m/s). In addition, grout curtain and channel plugging techniques should be used for construction of the 100 m high underground dam and the power plant (60 megawatts) should be situated also underground. (See also W90-02444) (Author's abstract)
W90-02452

APPLICATION OF PROBABLE MAXIMUM FLOOD ESTIMATES TO THE DESIGN OF WATER RESOURCE DEVELOPMENT PROJECTS.
Harza Engineering Co., Chicago, IL.
For primary bibliographic entry see Field 2E.
W90-02509

DESIGN FLOODS FOR CANAFISTO DAM.
Integral S.A., Medellin (Colombia).
For primary bibliographic entry see Field 2E.
W90-02513

FLOOD ANALYSES PERTAINING TO DESIGN OF NUCLEAR POWER PLANTS.
Stone and Webster Engineering Corp., Boston, MA.
For primary bibliographic entry see Field 2E.
W90-02524

REVIEW OF ADVANCES IN RISK AND RELIABILITY ANALYSIS FOR HYDRAULIC STRUCTURES.
Texas Univ. at Austin. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W90-02526

CORPS OF ENGINEERS PROCEDURES FOR EVALUATING AND MODIFYING EXISTING DAMS TO SAFELY ACCOMMODATE THE CURRENT INFLOW DESIGN FLOOD.
Corps of Engineers, Washington, DC. Hydraulics and Hydrology Branch.
R. G. Huffman.
IN: Application of Frequency and Risk in Water Resources: Proceedings of the International Symposium on Flood Frequency and Risk Analyses, 14-17 May 1986, Louisiana State University, Baton Rouge, U.S.A. D. Reidel Publishing Company, Boston, MA. 1987. p 405-409.

Descriptors: *Design floods, *Dam design, *Dams, *Safety, *Economic aspects, Hydrology, Flood control, Flood frequency, Policy making.

It is the Corps practice to design dams above populated areas to safely accommodate the largest flood considered physically possible. This magnitude of flood is referred to as the Probable Maximum Flood (PMF). The Corps existing dams are being evaluated to determine how safely they could accommodate inflow floods up to a PMF developed in accordance with todays standards. If it is found that failure of a dam could endanger peoples' lives, a modification of the dam would developed that would remove the threat to human life. Alternatives will be studied to determine the least costly modification that will meet the requirement, not to endanger lives. Economic analysis, that is comparing average annual benefits to average annual cost, will not be used as a basis for selecting the dam modification. The objective of economic analysis is to maximize net benefits, to make the very best decision. In the case of dam safety, the best decision is not possible and a more appropriate decision criterion is to try to avoid making bad decisions. Designing a dam so that it will not endanger lives in the event a large flood up to the PMF magnitude should occur is such a decision criteria. (See also W90-02507) (Stoehr-PTT)
W90-02537

BUREAU OF RECLAMATION USE OF RISK ANALYSIS.
Bureau of Reclamation, Denver, CO.
For primary bibliographic entry see Field 7C.
W90-02538

TVA PRACTICE IN FLOOD FREQUENCY AND RISK ANALYSIS.
Tennessee Valley Authority, Knoxville. Flood Protection Branch.
For primary bibliographic entry see Field 2E.
W90-02539

SOME REMARKS ON PRACTICE OF FLOOD FREQUENCY AND RISK ANALYSIS BY THE FEDERAL ENERGY REGULATORY COMMISSION.
Federal Energy Regulatory Commission, Washington, DC.
For primary bibliographic entry see Field 2E.
W90-02544

8B. Hydraulics

NUMERICAL ANALYSIS OF THE RESONANCE POSSIBILITIES OF A HARBOR BASIN OF VARIABLE DEPTH (UNE ANALYSE NUMERIQUE DES POSSIBILITIES DE RESONANCE D'UN BASSIN PORTUAIRE DE PROFONDEUR VARIABLE).
Ecole Polytechnique, Montreal (Quebec). Dept. of Civil Engineering.
N. Serhir-Taleb, and C. Marche.
Canadian Journal of Civil Engineering CJCEB8, Vol. 16, No. 4, p 467-476, August 1989. 12 fig, 2 tab, 6 ref.

Descriptors: *Waves, *Hydraulics, *Harbors, *Model studies, *Resonance, Water depth, Numerical analysis.

Creating, enlarging and excavating a harbor can modify the dynamic response of the basin. A verification of the resonance modes is common practice before undertaking such work. This can be done numerically if the necessary assumptions are verifiable. It can be done on a small-scale model if the basin has an irregular shape or if the depth varies from one area to the other. A computer-programmed analytical method of resonance modes is presented. It is derived from the direct measure principle of successive oscillation superposition used in the laboratory. Validation is obtained by applying the method to existing theoretical solutions and to the analysis of a small creek of the Gaspe Peninsula where the importance of refraction in the analytical results is demonstrated. (Author's abstract)
W90-01981

KINZUA DAM, ALLEGHENY RIVER, PENNSYLVANIA AND NEW YORK: HYDRAULIC MODEL INVESTIGATION.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.
W. B. Fenwick.
Available from the National Technical Information Service, Springfield, VA 22161, As ADA212430. Price codes: A04 in paper copy, A01 in microfiche. Technical Report HL-89-17, August 1989. Final Report. 5p, 5 fig, 4 tab, 17 photos, 5 plates, append.

Descriptors: *Dam design, *Sediment control, *Hydraulic models, *Pennsylvania, New York, Allegheny River, Hydraulic structures, Kinzua Dam, Model studies, Erosion, Stilling basins, Sluice gates, Spillways.

A hydraulic model of Kinzua Dam, Pennsylvania, was used to evaluate various methods of preventing riverbed material from entering the stilling basin and causing erosion problems. Major spillway rehabilitation projects required in 1973 and again 1983 prompted this study. Adversre currents (return eddies) have brought bed material back into the basin and eroded holes up to 25 ft in diameter and 42 in. deep in the concrete. Various sluice operational modes were evaluated along with structural modifications such as debris traps and sloping and sills. The discharge ends of the

upper sluices were modified in several ways in an attempt to eliminate the circular current patterns in the stilling basin. The model was also used to confirm satisfactory performance of the spillway and stilling basin during passage of the design flood. A rock trap selected as the final design was constructed in the prototype in the fall of 1983 and has been most effective in keeping material out of the basin to date. Strict adherence to the sluice gate operating schedule has been enforced and has also contributed to the success of the final solution. (Lantz-PTT)
W90-02292

RECENT ADVANCES IN HYDRAULIC PHYSICAL MODELLING.
Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. 627p. Edited by Rui Martins.

Descriptors: *Oil dispersants, *Dispersants, *Hydraulics, *Physical models, *Hydraulic models, *Model studies, Rivers, Hydraulic structures, Physical properties, Density.

Physical models in hydraulics continue to be developed: more precise use of similitude criteria, better knowledge of scale effects, new and more complex types of model, use of various artifices, more adequate instrumentation, automation of the operation of models--all these point to that development. The NATO Advanced Study Institute on Recent Advances in Hydraulic Physical Modelling, which took place on the premises of the Laboratorio Nacional de Engenharia Civil (LNEC) in Lisbon, Portugal, from 4th to 15th July 1988, was an evaluation and discussion of the current situation with respect to physical models in hydraulics. This book is the main output from the study institute, and is divided into 11 chapters corresponding to 28 lectures that cover five areas: fundamentals of physical modeling, river models, hydraulics of structures, maritime hydraulics and density models. (See W90-02359 thru W90-02367) (Lantz-PTT)
W90-02358

FUNDAMENTALS OF HYDRAULIC PHYSICAL MODELLING.
Queen's Univ., Kingston (Ontario). Dept. of Civil Engineering.
M. S. Yalin.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 1-37, 5 fig, 12 ref, 2 append.

Descriptors: *Model studies, *Oil dispersants, *Dispersants, *Hydraulics, *Physical models, *Hydraulic models, Physical properties, Mathematical studies, Dimensional analysis.

A physical model is a precision device used in order to predict the behavior of a physical phenomenon. A model can be regarded as reliable only if it is designed correctly. A small-scale reproduction of a physical phenomenon can be a valid model if its pertinent quantitative characteristics are related to their counterparts in the actual phenomenon (in the prototype) by certain constant proportions which satisfy certain definitive conditions. These constant proportions are referred to as scales, the conditions satisfied by the scale being criteria of similarity. Previously, the criteria of similarity were derived from mathematical relations (usually the differential equations) describing the nature of the phenomenon under investigation. Information on the contemporary approach to physical modeling, which rests on the dimensional method is presented. This method supplies criteria of similarity from the dimensional study of the pertinent characteristics themselves (and not from mathematical descriptions of the phenomenon). Accordingly, the criteria of similarity are obtained without undergoing any risk of possible misinterpretations (which may be inherent in mathematical formulations). Another advantage of the approach is the determination of the model scales does not depend on the nature of the protype (the magnitude of its flow depth, flow rate, slope, etc.). (See also W90-02358) (Lantz-PTT)
W90-02359

RIVER MODELS.
Laboratoire National d'Hydraulique, Chatou (France).
For primary bibliographic entry see Field 2E.
W90-02360

MODELS FOR STUDY OF THE DYNAMIC BEHAVIOUR OF STRUCTURES IN FLOW AND WAVES.
Waterloopkundig Lab. te Delft, Emmeloord (Netherlands). De Voorst Lab.
P. A. Kolkman.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 65-142, 37 fig, 1 tab, 12 ref, 13 append.

Descriptors: *Oil dispersants, *Dispersants, *Hydraulics, *Physical models, *Hydraulic models, Mathematical studies, Elastic properties, Flow profiles, Vibrations, Flow pattern.

Before flow-induced vibrations and response to hydrodynamic action can be determined the following differentiation (in the order of increasing level of danger) must be made: (1) the passive response to excitation by waves or turbulence; (2) body-controlled excitation, where initially unstable flow phenomena can be amplified by body vibration, or where vibration of the body synchronizes the random turbulence excitation acting on different parts; and (3) self-excitation or negative damping, where the dynamic flow excitation is purely induced by the body vibration itself (feedback). Remedies for flow-induced vibrations may consist of reshaping the structure (e.g. to stabilize the flow pattern by fixation of the flow separation and/or the flow reattachment point, to shift the excitation frequency, or to disturb the regularity of vortex shedding), in increasing the rigidity (which reduces initial deflections and the possibility of self-excitation and which also results in a shift of the resonance frequency), and in the application of mechanical damping. These remedies are expanded upon and mathematically analyzed by means of: the response calculation at random excitation; the introduction to added mass, added damping, added rigidity and self-excitation; models with elastic similarity for the investigation of hydraulic structures; and the use (application and limitations) of physical models in vibration research. Twelve case studies are appended to this paper as examples of gate vibration in prototypes and models. (See also W90-02358) (Lantz-PTT)
W90-02361

MODELS FOR STUDY OF THE HYDRODYNAMIC ACTIONS ON HYDRAULIC STRUCTURES.
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
C. M. Ramos.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 143-189, 22 fig, 2 tab, 43 ref.

Descriptors: *Model studies, *Oil dispersants, *Dispersants, *Hydraulic structures, *Hydrodynamics, *Hydraulic models, *Dam stability, *Dams, Structural engineering, Structural behavior, Vibrations, Mathematical studies, Oscillatory waves, Dam foundations.

In the conception of dams and appurtenant works, especially when they create high heads and/or are located in rivers with large discharges the correct design of spillways is of special importance. For this design, the evaluation of hydrodynamic actions on the structural elements of the stilling basins, due to the pressure field induced by the macroturbulence of the flow, is one of the fundamental aspects in the analysis of their stability. According to previous reports, about 5% of the total number of cases of deterioration observed in appurtenant works of dams were due to turbulence. To illustrate the importance of the problem of hydrodynamic actions on hydraulic structures, some examples are given of cases of deterioration observed on stilling basins of spillways of various dams--the stilling basins of the Netzahualcoyotl (Malpaso) Dam, in Mexico, Bhakra Dam, in India, Bratsk, Boutcharninsk, Pavlovsk, Krasnoiarsk and Sayano--Sushenskoe Dams, in USSR, Tarbela Dam, in Pakistan, and Pit 6 and Pit 7, in USA. Among these cases, special attention is given to the damage observed in Netzahualcoyotl Dam stilling basin, 100 m long, 50 m wide and 26 m deep, designed for a maximum head of 118 m. This stilling basin was protected with concrete floor slabs 12 m X 12 m X 2 m, that weighed 7,000 kN, anchored with twelve 1-1/4 in steel bars. The spillway was designed for a discharge of 11,000 cu m/sec. However, after a discharge of 3,000 cu m/sec that occurred during two weeks, major damage was reported. After inspection it was observed that many of the central slabs had been completely removed. The anchorage showed signs of tension failure, and the foundation rock presented erosion down to a depth of 6 m below its original level. Physical model studies showed that slabs could be lifted vertically as a consequence of differential pressure fluctuations between the upper and lower surfaces of these structural elements. (See also W90-02358) (Lantz-PTT)
W90-02362

DENSITY MODELS.
Bechtel Civil, Inc., San Francisco, CA.
P. J. Ryan.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 191-255, 28 fig, 1 tab, 80 ref.

Descriptors: *Oil dispersants, *Dispersants, *Density flows, *Model studies, *Physical models, *Flow profiles, *Thermal pollution, *Hydraulic models, Stratification, Stagnant water, Density models, Flow velocity.

The term 'density model' is defined as a model of fluid motions in a gravitational field in which the variations of density within the field originate or influence the flow field. Strictly speaking, this applies to all free surface fluid motions, but in this case the emphasis is on motion involving fluid masses of the same state, and with relatively small density differences. A relatively simple model study of a thermal discharge into a stagnant river was performed. Since all three processes, jet mixing, stratified flow and surface heat loss, were important, it was not possible to accurately simulate the prototype behavior. However, the density model employed was sufficient to demonstrate that the concept of a low velocity discharge, angled downstream, and an upstream skimmer wall intake, was workable. Using the appropriate scaling laws for surface heat loss, corrections to the model measurements of recirculation were possible, allowing a reasonable estimate of prototype recirculation to be made. (See also W90-02358) (Lantz-PTT)
W90-02363

TIDAL MODELS.
Technical Univ. of Lisbon (Portugal). Inst. Superior Tecnico.
For primary bibliographic entry see Field 2L.
W90-02364

HYBRID MODELLING AS APPLIED TO HYDRODYNAMIC RESEARCH AND TESTING.
National Research Council of Canada, Ottawa (Ontario). Hydraulics Lab.
V. Barthel, and E. R. Funke.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 303-390, 74 fig, 16 ref.

Descriptors: *Oil dispersants, *Dispersants, *Hydrodynamics, *Physical models, *Model studies, *Hydraulic models, *Mathematical models, Estuaries, Tidal hydraulics, River flow.

The solution of engineering or scientific problems by modeling has been practiced since the early days of engineering. Fundamental to all analog and numerical simulation techniques are the mathematical formulations of the problem. Most engineers, who have been exposed to both the scaled physical model and the mathematical model techniques, know fully well that there are limitations associated with each of them. When a physical model is planned, one is always faced with the choice of a suitable scale factor. In most cases, the scale factor will have to be a compromise between the available floor space in the laboratory, the area to be reproduced and undesirable scale effects. The hybrid model combines both physical and mathematical modelling, and attempts to use the advantages of both methods, giving the model engineer greater freedom in choosing a scale factor for physical model. The concept and principles of the real-time hybrid model are described with particulars emphasis on requirements, limitations, and characteristics of an example hybrid model of a simple tidal estuary situation in which the upstream portion is a physical model and an adjacent downstream portion is a one-dimensional mathematical model. Problems associated with hybrid models are: (1) Start up problems; it may take a tidal cycle or two before the model has settled down; (2) Cross-mode instabilities; this can be overcome by mechanical or digital filtering; and (3) The effects of an uncalibrated tidal gauge or pump system; careful choice of instrumentation and accurate calibration are the answer. (See also W90-02358) (Lantz-PTT)
W90-02365

DYNAMIC ACTIONS ON BREAKWATER (RUBBLE-MOUND AND CAISSON/COMPOSITE TYPE BREAKWATERS).
Dansk Hydraulisk Inst., Hoersholm. Ports and Marine Structures Dept.
O. J. Jensen.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 503-566, 54 fig, 2 tab, 57 ref.

Descriptors: *Oil dispersants, *Dispersants, *Hydrodynamics, *Breakwaters, *Model studies, *Caissons, *Physical models, Rocks, Hydraulic models, Model studies, Wave action, Mathematical studies.

A considerable amount of research has been conducted in recent years within the field of rubble-mound breakwaters due to the many and costly applications of rubble mound breakwaters and the considerable number of failures and severe damage. Waves breaking on a slope involve non-stationary velocity and acceleration fields during run-up and run-down. On a rubble-mound structure the process is further complicated by the fact that rubble-mound breakwaters are permeable structures with water reservoir capacity and high energy absorption. For rubble-mound breakwaters, overtopping is an important design element and model results introducing different means to reduce overtopping are presented. For important marine projects caisson/composite breakwaters have for many years been an alternative to rubble-mound type breakwaters. However, in recent years, not many caisson breakwaters are constructed and consequently the technology has not recently developed significantly as for rubble-mound breakwaters. The effect wave forces have on caisson breakwaters is documented by results from practical applications with particular focus placed on the determination of design loads based on model test results. In addition to the overall wave forces, local wave forces may be of importance and be affected by the geometry of a protruding parapet which is a structural element often introduced in an attempt to reduce overtopping. (See also W90-02358) (Lantz-PTT)
W90-02366

PHYSICAL MODELLING OF LITTORAL PROCESSES.
Delaware Univ., Newark. Dept. of Civil Engineering.
R. A. Dalrymple.
IN: Recent Advances in Hydraulic Physical Modelling. Kluwer Academic Publishers, Dordrecht, The Netherlands. Series E: Applied Sciences-Volume 165, 1989. p 567-588, 4 fig, 62 ref. Sea Grant NA86AA-D-SG-040 (R/OE-1) and NSF Project MSM-8712203.

Descriptors: *Oil dispersants, *Dispersants, *Physical models, *Littoral zone, *Coastal waters, *Wave action, Intertidal areas, Hydraulic models, Bays, Estuaries.

Construction along the coastline, for harbors and waterways, or for the mitigation of beach erosion, requires a proper understanding of the interaction of the structure with the shoreline. State-of-the-art coastal engineering numerical models are good for nonlinear water waves at a fixed location on a flat bottom. There are two types of physical models that are carried out in coastal engineering. The first is the model to verify the predictions of other models. These physical models may have no relationship to a prototype and in fact may not correspond to anything in the real world; however, they do provide a (often a simple) test case for a numerical model. The second type of physical model is the prediction of prototype behavior. This is a more difficult model due to the problems of scaling. While large tidal models exist to study the hydrodynamics of bays and estuaries and numerous models have been developed to study the wave environment in harbors, far fewer models have been built of prototype shoreline conditions, largely due to the problems with scaling of littoral processes. There is no one correct scaling relationships, and modeling is still an art. A review is presented of coastal processes to provide a background to coastal modeling. Other topics reviewed include: modelling facilities, hydrodynamic physical models, and littoral process models. In order to test a model that simulates prototype conditions, it is necessary to obtain a considerable amount of data about the prototype, including bathymetric surveys (over a long period of time), sediment sizes, sediment transport rates, and wave climates. These data are necessary for the initial verification of the model, which is crucial to evaluate the ability of the chosen model law. (See also W90-02358) (Lantz-PTT)
W90-02367

SEWERAGE SYSTEMS: OVERFLOW PROBLEMS AND RENOVATION METHODS.
Plancenter Ltd., Finland.
For primary bibliographic entry see Field 5D.
W90-02414

RENOVATION OF THE STOCKHOLM SEWERAGE SYSTEM.
Stockholm Water and Wastewater Works (Sweden).
For primary bibliographic entry see Field 5D.
W90-02415

8C. Hydraulic Machinery

ENVIRONMENTAL BENEFITS OF FURTHER US HYDRO DEVELOPMENT.
Synergics, Inc., Annapolis, MD.
For primary bibliographic entry see Field 6G.
W90-02035

DESIGN AND PERFORMANCE OF THE CAT ARM DAMS AND TUNNELS.
Golder Associates, Inc., Atlanta, GA.
For primary bibliographic entry see Field 8A.
W90-02036

FRANCIS TURBINE SETTING.
Monenco Consultants Ltd., Montreal (Quebec).
J. L. Gordon.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 24-27, August 1989. 3 tab, 14 ref.

Descriptors: *Design criteria, *Turbines, *Cavitation, Mathematical equations, Throat diameter, Costs, Velocity, Turbine settings.

The first evidence of cavitation in a Francis unit usually appears on the underside of the blades, near the trailing edge. This area is at a distance of about d/4 below the centerline, where d is the turbine throat diameter, and casing centerline is the commonly used reference level for unit setting with respect to tailwater. Since the turbine cost is proportional to the throat diameter raised to the power 2.5 (for small changes in diameter) and since the generator cost decreases by about 6-8% for every 10% increase in speed, there is a major incentive to use ever higher specific speeds. However, the negative aspects must also be included in the assessment, and these are: additional foundation excavation; extra dewatering costs; higher cost draft tube gates; possibly a longer generator shaft; a higher crane rail; additional superstructure steel and siding costs for the higher crane; more leakage at the shaft gland seal; a higher risk of water contaminating the turbine bearing oil; and additional difficulty in aerating the turbine during part-load operation. The methodologies outlined provide an alternative method for determining the turbine setting, and also a method of comparing proposals which include turbines with differing throat diameters; throat diameter is important, since setting is a function of velocity squared, a 2% change in throat diameter produces an 8% change in the velocity head. (White-Reimer-PTT)
W90-02038

SIPHON INTAKES FOR SMALL HYDRO PLANTS IN CHINA.
Hangzhou Regional Center For Small Hydropower (China).
X. H. Wang.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 44-53, August 1989. 9 fig, 14 ref.

Descriptors: *Hydroelectric plants, *Hydroelectric power, *China, *Intakes, *Siphons, Priming, Diversion plants, Reservoir plants, Hydraulic efficiency, Water level, Water depth, Case studies, Head loss.

In the Dishan siphon-type power conduit system (spc system) plant each unit could be started by self-priming which has the advantage of convenience, timesaving, and conservation of electricity. The main disadvantage of the spc systems is that their application range is limited to diversion-type plants or reservoir plants of which the fluctuation of headrace level is less than 4 or 5m. From the viewpoint of hydraulic efficiency, the configuration of a siphon intake should observe the same principle as that of a gated intake: to reduce the head loss to a minimum. The minimum water level is generally determined by the plant operation and the maximum water level should be lower than the elevation of the crest of the siphon. The submergence depth should be determined on a reasonably conservative basis although smaller submergence could save some construction costs. Other aspects of the spc system described include: (1) priming by gates or stoplogs on a side spillway; (2) injector-piping system; (3) container-type primer; (4) self-priming; (5) waterhammer, speed regulation and runaway; (6) design vacuum and range of siphon intakes; and (7) specific case studies in China. (White-Reimer-PTT)
W90-02042

EFFECT OF AN IRRIGATION AND HYDROELECTRIC RESERVOIR ON ITS DOWNSTREAM COMMUNITIES.
Universidad Autonoma de Madrid (Spain). Dept. de Ecologia.
For primary bibliographic entry see Field 6G.
W90-02047

ROLE OF HYDROPOWER IN THE WORLD'S ENERGY SUPPLY.
For primary bibliographic entry see Field 6D.
W90-02127

PALMIET PUMPED-STORAGE SCHEME BEGINS DUAL-ROLE OPERATION.

Electricity Supply Commission, Johannesburg (South Africa). Hydro and Water Supply Engineering Div.
W. Z. Pyzikowski.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 9 p 38-45, September 1989. 4 fig, 2 tab.

Descriptors: *Dams, *Hydroelectric power, *Pumped storage, *Water resources development, Storage reservoirs, Multireservoir networks, Penstocks, Tailrace, Surge tanks, Overflow channels, Tunnel construction, Powerplants, Interbasin transfers, Pumping, Remote control, South Africa.

The second major pumped-storage plant operated by the South African national utility ESKOM recently began operation. The Palmiet scheme operates between two artificial reservoirs some 2.2 km apart, and with an average difference in elevation of approximately 280 m. It is a 400 Mw facility, which has a weekly operating cycle for peak power production, and a secondary role of water transfer to the Steenbras river catchment area. During the scheme's weekly operating cycle, the rated output of 400 Mw can be generated for up to 10 h each day from Monday to Friday. Every night, part of the water used for generation is to be pumped back, resulting in a gradual emptying of the upper reservoir. When completely empty, the upper reservoir will be refilled by a long period or periods of pumping during the weekend, extending in total over approximately 33 h. Components of the system include the Rockview upper reservoir, the Kogelberg lower reservoir, waterways extending between the upper and lower reservoirs over a horizontal distance of approximately 2.1 km, a headrace intake structure and conduit, a surge tank, a pressure shaft and tunnel, a penstock, and tailrace tunnels and outfall structure. The powerhouse complex consists of machine-hall and service shafts, a control room, and the machine-hall surface building, with switchgear and administration annexes. The Palmiet scheme has a number of special operating advantages. Features such as starting and load acceptance within approximately 2 min as well as the possibility of remote control from the National Control Centre, are particularly valuable. (Ence-PTT)
W90-02128

SAINT AIGNAN: A DEMONSTRATION SIPHON PLANT IN BRITTANY.
Neyrpic, Grenoble (France).
R. Pontier, A. Donot, and C. Petillon.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 9 p 45-49, September 1989. 2 fig.

Descriptors: *Siphons, *Turbines, *Hydraulic turbines, *Concrete dams, *Hydroelectric power, *Siphon turbines, *Water resources development, *Rural areas, *Developing countries, Dam effects, Hydraulic design, Tunnel construction, Costs, Maintenance, Environmental protection, France.

Modern engineering and project management techniques, giving optimum low-head generation economics, are being utilized in a new hydropower station in Brittany, France. This demonstration siphon plant will be opened to visitors beginning the summer of 1989, and is of particular interest for rural areas and developing countries. The siphon turbine concept is particularly suitable for areas where run-of-river plants can harness rivers having wide seasonal variations. It is suitable for heads of between 1 and 4.5 m. The siphon water passage is primed using a vacuum; when generation is no longer required, air-break valves stop the flow. The concept offers the advantage, apart from a cost gain over other low-head units (such as pit or bulb units), of keeping the electromechanical equipment above the tailwater level. This enables easy access for maintenance. Other interesting features for regions where environmental aspects are important are the small disturbance and impact on the surroundings, the relatively small excavation required for the installation, and the usual ecological advantage of Kaplan turbines over other types for fish protection. The future potential of the siphon technique can already be seen; during a recent project bid, three siphon units were seen to be about 30 percent cheaper (on first electromechanical price comparison) than two right-angled drive units of equivalent installed capacity. (Ence-PTT)
W90-02129

8D. Soil Mechanics

PANGNIRTUNG WATER RESERVOIR: GEOTECHNICAL ASPECTS.
Thurber Consultants Ltd., Calgary (Alberta).
L. B. Smith, W. G. Notenboom, M. Campbell, C. Cheema, and T. Smyth.
Canadian Geotechnical Journal CGJOAH, Vol. 26, No. 3, p 335-347. August 1989. 16 fig, 2 ref.

Descriptors: *Reservoir construction, *Canada, *Geophysics, Excavation, Thawing, Sand, Till, Drill holes, Permafrost, Canada.

The geotechnical aspects associated with the design and construction of an earthworks water reservoir excavated in ice-rich permafrost in the community of Pangnirtung, N.W.T. are presented. The reservoir was constructed by blasting, excavating, and using frozen silty sand to form reservoir berms during the winter. The work involved the excavation of about 140,000 cu m of material. An air-track drill proved useful in this remote area because it permits a large number of test holes to be made through most types of frozen ground in a short period of time. However, since the drill holes are encased, it was difficult to evaluate the properties and strength of the frozen soils. Therefore, a thorough understanding of the geology of the site is necessary. The silty sand till at this site was generally thaw stable and trafficable during the first thaw season, since the material drained faster than it thawed; however, this behavior may not occur in ice-rich clayey soils. The successful excavation of the Pangnirtung reservoir demonstrates that deep excavations in ice-rich permafrost are practical and cost effective. While it proved possible to excavate the lower, ice-poor material progressively as it thawed fewer construction difficulties would have been encountered if the excavation had been carried to its full depth by blasting during the winter. (Author's abstract)
W90-01959

MODELING SOIL SEAL AS A NONUNIFORM LAYER.
Hebrew Univ. of Jerusalem (Israel). Seagram Centre for Soil and Water Sciences.
For primary bibliographic entry see Field 2G.
W90-02188

8E. Rock Mechanics and Geology

RESEARCH ON RESERVOIR INDUCED SEISMICITY.
Retom Geo-Research and Engineering, Inc., Calgary (Alberta).
T. Vladut.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 30, August 1989.

Descriptors: *Seismic properties, *Dam stability, *Dam design, *Reservoirs, Earthquakes, Seismic waves, Model studies, Reservoir construction, Reservoir design, Mitigation measures, Stress path assessment.

Reservoir induced seismicity (RIS) is recognized as a significant environmental issue, related to dam safety and important to take into account in the design of large dams. A risk prediction model has been derived that is based on a relatively good correlation of field data for 20 reservoirs which were thought to have induced seismic activity. The first confirmation of the predicted seismic behavior was obtained for the La Grande river reservoir, which allowed for a detailed analysis of the model's potential to be carried out. The impounding process implies a continuous sequence of modifications to the shape of the storage, and in particular for each increase in depth, a different stress condition develops. The impounding thus corresponds to a continuous stress modification and an associated stress path could be identified on the risk identification diagram. The increased awareness of the risk of RIS in the last decade has led to some mitigation measures, such as slower rates of impounding. In particularly risk-prone areas, a specific impounding rate may be called for in the design. The design specification will take into account the stress path assessment method. (White-Reimer-PTT)
W90-02039

RESEARCH ON HYDROGEOLOGY IN KARST REGIONS OF CHINA.
Academia Sinica, Beijing (China). Inst. of Geology.
For primary bibliographic entry see Field 2F.
W90-02445

ENVIRONMENTAL AND ENGINEERING EFFECTS OF SINKHOLES--THE PROCESSES BEHIND THE PROBLEMS.
Florida Sinkhole Research Inst., Orlando.
For primary bibliographic entry see Field 2F.
W90-02447

KARST ENVIRONMENTAL SYSTEM.
Institute of Karst Geology, Guilin (China).
For primary bibliographic entry see Field 2F.
W90-02448

KARST HYDROGEOLOGY OF THE STRIKE-SLIP FAULT OF THE MOUNT AUBERT (SWISS JURA).
Liege Univ. (Belgium). Labs. de Geologie de l'Ingenieur, d'Hydrogeologie.
P. Meus.
IN: Karst Hydrogeology and Karst Environment Protection. Vol. 1. International Association of Hydrological Sciences Press, Institute of Hydrology, Wallingford, Oxfordshire, UK. 1988. p 353-358. 4 fig, 4 ref.

Descriptors: *Geohydrology, *Switzerland, *Karst hydrology, *Aquifers, *Hydrodynamics, Dye releases, Springs, Water chemistry.

Mount Aubert, Switzerland, is the southernmost asymmetric anticline of the Jura range, bordering the lake of Neuchatel directly on the north. Karstified jurassic and cretaceous limestones of the fold are disturbed by an important oblique strike-slip fault. It allows exchanges between aquifers through several series of impervious marls. Moreover, high performance, especially near the dislocation, account for a well structured karstic drainage. The Raisse spring and its overflow, the Dia spring, are the main discharges at the end of the fault. Several methods have been used to determine the features of karstic flows in relation with this structure. The fault behaves like a drain, as shown by underground water tracing, though a diffluence can sometimes be observed during flood events. The heterogeneity of permeability and the relation between both springs are emphasized by seasonal and flood fluctuations in hydrodynamics and hydrochemistry. (See also W90-02444) (Author's abstract)
W90-02483

8F. Concrete

INTEGRATED ANALYSIS OF DEFORMATION SURVEYS AT MACTAQUAC.
New Brunswick Univ., Fredericton. Dept. of Surveying Engineering.
A. Chrzanowski, Y. Q. Chen, J. M. Secord, A. Szostak-Chrzanowski, and D. G. Hayward.
International Water Power and Dam Construction IWPCDM, Vol. 41, No. 8, p 17-22, August 1989. 6 fig, 8 ref.

Descriptors: *New Brunswick, *Dams, *Canada, *Concrete dams, *Deformation, Mactaquac dam, Alkali-aggregate reaction, Monitoring, Dam fail-

ure, Model studies, Performance evaluation, Integrated analysis, Mathematical equations.

Unusual remedial measures have recently been taken at the Mactaquac dam and associated structures in Canada to relieve and control the long-term effects of alkali-aggregate reaction in the concrete. To better understand the mechanism and causes of deformation, and extensive monitoring scheme was developed which included precision geodetic surveys and measurements with geotechnical instruments such as multirod borehole extensometers, invar tape extensometers, suspended and inverted plumblines, and various joint meters and tell-tales across the joint openings and structural cracks. The University of New Brunswick (UNB) generalized method of deformation analysis was then employed. The main task of deformation analysis is to obtain a displacement function which characterizes the deformation in time and space. Since, in practice, deformation surveys involve only discrete points, the displacement function must be approximated through some selected model which fits observation data in the best possible way. In spite of the complexity involved with the various sources and quality of data, the various location for observation, and behavior of the structure, an integrated analysis of the deformation of the powerhouse was achieved. The UNB generalized method, which provides a unique tool to describe mathematically the displacement field from various types of observables, made possible the integrated analysis. The displacement model allowed for the derivation of the strain field which was essential for subsequent physical interpretation of the deformation. (White-Reimer-PTT)
W90-02037

MONOLITH JOINT REPAIRS: CASE HISTORIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
J. G. May, and J. E. McDonald.
Available from the National Technical Information Service, Springfield, VA 22161, as ADA212814. Price codes: A04 in paper copy, A01 in microfiche. Technical Report REMR-CS-22, August 1989. Final Report. 69p, 58 fig, 1 tab, 30 ref.

Descriptors: *Maintenance, *Concretes, *Construction joints, *Dams, Locks, Monolith joints, Epoxy resins, Case studies, Weathering, Grouting.

The Corps of Engineers currently operates and maintains 545 dams and 269 lock chambers at 605 sites. These structures are routinely exposed to deleterious forces, such as impact and abrasion damage from navigation traffic. Monolith joints are the fourth most common location for deficiencies in dams and the third for locks. A study was conducted to identify materials and techniques used to repair deteriorated monolith joints, excluding joint sealant failures or seepage. A secondary objective was the identification of areas in which further research is needed to supplement existing technology. Spalling is the most common deficiency for monolith joints in locks and dams when seepage and joint sealant failure are not considered. Spalling is followed by distortion and cracking. Although damage from impacts and cycles of freezing and thawing are the primary causes of deficiencies in the case history repairs, settlement is the primary cause listed in the WES damage and repair data base. For dams, settlement is followed by erosion, temperature, and maintenance faults. For locks, settlement is followed by weathering, shrinkage, and construction faults. A wide variety of repair materials are available. Conventional concrete, fiber-reinforced concrete, wet-mix and dry-mix shotcrete, fiber-reinforced shotcrete, and epoxy grout are some of the materials that have been used in monolith joint repairs. In the selection of a repair material, several characteristics must be considered. The repair material should be compatible with the in situ material with emphasis on the coefficient of thermal expansion and modulus of elasticity. It should be strong and have the ability to resist damage from impact loads. The repair material should demonstrate volume stability during and after curing and develop good bond strength. The material must be able to perform in the wet lock-chamber environment and resist damage from cycles of freezing and thawing. Permeability and thermal stresses from the hydration process must also be considered, although they are not as critical for a joint repair as they are for a large-scale overlay. Finally, the economy of the material should be considered, both from the standpoint of initial cost and long-term maintenance cost. (Lantz-PTT)
W90-02290

8G. Materials

PANGNIRTUNG WATER RESERVOIR: GEOTECHNICAL ASPECTS.
Thurber Consultants Ltd., Calgary (Alberta).
For primary bibliographic entry see Field 8D.
W90-01959

MONOLITH JOINT REPAIRS: CASE HISTORIES.
Army Engineer Waterways Experiment Station, Vicksburg, MS. Structures Lab.
For primary bibliographic entry see Field 8F.
W90-02290

DURABILITY OF SEWER PIPES: A LITERATURE STUDY ON DETERIORATION MECHANISMS (DUURZAAMHEID RIOOILEIDINGEN EEN LITERATUURSTUDIE NAAR AANTASTINGSMECHANISMEN).
Commissie voor Hydrologisch Onderzoek TNO, The Hague (Netherlands).
R. B. Polder.
Available from National Technical Information Service, Springfield, VA 22161 as PB88-188172/GAR. Price codes: E04 in paper copy, A01 in microfiche, 1987. Report-17, ISBN-90-6743-100-1. 61p, 73 ref. English summary.

Descriptors: *Sewers, *Pipes, *Concretes, *Degradation, *Literature review, *Materials engineering, Chemical degradation, Sulfuric acid, Anaerobic conditions, Sulfur bacteria, Wastewater, Temperature effects, Sulfides.

A survey of the literature on degradation of sewer pipes showed that one particular mechanism is dominant in the degradation of concrete sewer pipes. This mechanism is known as Biogenic Sulfuric Acid Attack (BSA). Under anaerobic conditions sulfate in the sewage is reduced to sulfide by the action of bacteria. The mechanism of BSA has been thoroughly investigated, resulting in several equations to predict the occurrence of attack and its rate. Calculations involve various combinations of dimensions of the pipeline, oxygen content and demand of the sewage, temperature, sewage flow and alkali content of the concrete. The various chemical methods of reducing sulfide build up are judged very differently in literature (especially with respect to costs). (Author's abstract)
W90-02443

8I. Fisheries Engineering

STREAM CHANNEL AND HABITAT CHANGES DUE TO FLOW AUGMENTATION.
Wyoming Water Research Center, Laramie.
For primary bibliographic entry see Field 2J.
W90-02043

EFFECT OF CALCIUM CONCENTRATION ON THE TOXICITY OF COPPER, LEAD AND ZINC TO YOLK-SAC FRY OF BROWN TROUT, SALMO TRUTTA L., IN SOFT, ACID WATER.
Nottingham Univ. (England). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W90-02177

LIFE HISTORY, ECOLOGY AND POPULATION STATUS OF MIGRATORY BULL TROUT (SALVELINUS CONFLUENTUS) IN THE FLATHEAD LAKE AND RIVER SYSTEM, MONTANA.
Montana Dept. of Fish, Wildlife and Parks, Kalispell.
For primary bibliographic entry see Field 2H.
W90-02214

HABITAT FEATURES AND TROUT ABUNDANCE RELATIVE TO GRADIENT IN SOME WYOMING STREAMS.
Forest Service, Fort Collins, CO. Wildlife and Fish Ecology Unit.
For primary bibliographic entry see Field 2H.
W90-02215

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

DIRECTORY: LANDSAT-RELATED PRODUCTS AND SERVICES.
Earth Observation Satellite Co., Inc., Lanham, MD.
For primary bibliographic entry see Field 7B.
W90-02297

INCREASING AWARENESS AND UNDERSTANDING OF FLOOD HAZARD AREAS AND FLOOD RISKS THROUGH PRINTED MATERIALS TARGETED TO SPECIFIC INTEREST GROUPS.
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 6F.
W90-02379

10D. Specialized Information Center Services

OVERVIEW OF THE TRENDS AND FUTURE DIRECTION OF INFORMATION TECHNOLOGY IN THE WATER INDUSTRY.
Water Research Centre, Medmenham (England).
M. J. Rouse, and R. F. Cranfield.
Water Science and Technology WSTED4, Vol. 21, No. 10/11, p 1129-1135, 1989.

Descriptors: *Water treatment, *Water management, *Information systems, *Computers, *Communications, *Data storage and retrieval, Economic aspects.

The last ten years has seen a dramatic change in computer applications in the Water Industry. Where previously the major applications and access to computing facilities were in the finance departments, the introduction of the personal computer (PC), with its relatively cheap cost, availability, and rapid growth of cheap, commercial software for a wide range of business, project planning and design applications, has brought computerization into the general office and design office. As important as the developments in hardware and software has been the rise of digital communications. The availability of high band width communications at attainable prices has completely changed system architectures. High speed, high volume networking across large geographic areas is now both feasible and economic. A major role for computers in the Industry today is in handling information-collecting it, storing it, retrieving and distributing it to whoever needs it. Looking at the next few years ahead, the current trend in hardware development will continue with commercially available processor power rising and real cost falling. The power of modern workstations is certain to be increasingly seen, particularly where their graphics capability is valuable. In the software field, obvious developments relate to database and expert systems. One area where fundamental changes are already at hand is in the increasing integration of systems. Where processes use similar data it make sense to ensure that each is compatible with the other. When the results of data collection are being used increasingly together for high level decision making, it becomes essential that the underlying data is correct and consistent. Integration to allow common data sources is

an obvious answer. This concept underlies the development of digital mapping as the common records base for a range of operational and planning decisions, each drawing on and adding to the same records base. The general communications field should see a capitalization on recent developments and the immediate future looks to offer more of the same at better prices, wider availability and higher reliability. (Sand-PTT)
W90-02054

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Baker (Michael), Jr., Inc., Alexandria, VA.
For primary bibliographic entry see Field 6F.
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River Services, Inc., Brookeville, MD.
For primary bibliographic entry see Field 6F.
W90-02381

INTEGRATED LOCAL FLOOD WARNING SYSTEM: A LOOK AT THE FLOOD RESPONSE SYSTEM.
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 6F.
W90-02382

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2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

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1990 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

Microfiche & Paper Copy Reports				Computer Products			
Standard Prices		*Exception Prices*		*Diskettes*		*Magnetic Tapes*	
A01	$8.00	E01	$10.00	D01	$50	T01	$165
A02	11.00	E02	12.00	D02	80	T02	220
A03	15.00	E03	14.00	D03	130	T03	340
A04–A05	17.00	E04	16.50	D04	180	T04	450
A06–A09	23.00	E05	18.50	D05	230	T05	560
A10–A13	31.00	E06	21.50	D06	280	T06	670
A14–A17	39.00	E07	24.00	D07	330	T07	780
A18–A21	45.00	E08	27.00	D08	380	T08	890
A22–A25	53.00	E09	29.50	D09	430	T09	1,000
A99	*	E10	32.50	D10	480	T10	1,110
		E11	35.00	D11	530	T11	1,220
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N01	$60.00	E13	41.00	D13	630	T13	1,440
N02	59.00	E14	45.00	D14	680	T14	1,550
N03	20.00	E15	48.50	D15	730	T15	1,660
		E16	53.00	D16	780	T16	1,770
		E17	57.50	D17	830	T17	1,880
		E18	62.00	D18	880	T18	1,990
		E19	69.00	D19	930	T19	2,100
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